The
Tropical Agriculturist
November, 1935

EDITORIAL

PASTURE AND FODDER GRASSES

EXPERIMENTS by the Department of Agriculture on the value of several indigenous and exotic grasses for the improvement of pasture areas have been in progress for about two years on the Experiment Station, Peradeniya, and have been conducted along two main lines, firstly, to investigate the possibilities of the variety of grass itself, and, secondly, to combine a grass with some leguminous plant with the object of obtaining a suitable pasture which will not only be palatable to cattle, but will be resistant to the invasion of other grasses and of weeds. The long drought prevailing during the past year has furnished a further severe but valuable test.

This preliminary work outlined in the Administration Report of the Director of Agriculture for 1934 has indicated that the most promising leguminous plant for use with pasture grasses under Peradeniya conditions would appear to be the wild Tick clover (*Desmodium triflorum*). This is readily established from cuttings and forms a low thick carpet not easily pulled up by grazing cattle. It is not seriously affected by drought and persists well in combination with a few of the better pasture grasses. Under the above conditions, one of the most suitable combinations has proved to be the common Carpet grass (*Axonopus compressus*) and Tick clover. This grass was introduced many years ago from the West Indies and has become one of our best natural pasture-forming grasses and produces a thick sward with the clover if grazed regularly. It has the further advantages of standing competition with wild grasses and of being drought-resistant. Golden Crown grass (*Paspalum dilatatum*), a popular fodder grass, is also a promising pasture grass which seems to combine well with Tick clover

when kept down by regular grazing. It has a tendency, however, to form tussocks. Kikuyu grass (*Pennisetum clandestinum*) shows possibilities of being a valuable pasture grass in different parts of the Island.

The usual method of attempting to establish pastures in Ceylon is by planting roots and cuttings, but with most grasses the growth is rather slow and uneven, allowing invasion by wild grasses and weeds. Moreover, there is a tendency eventually for the growth to become tufty and irregular. Experimental plots sown with imported grass seed have given promising results, but further trials are needed before the importation of grass seed on a large scale can be considered.

Considerable attention has been paid by the Department of Agriculture to the development of the better varieties of fodder grasses, plots of which are maintained on the more important stations for the dual purpose of cutting and feeding to working cattle and of supplying orders for planting material. The two established favourites are Napier or Elephant grass (*Pennisetum purpureum*) and Guinea Grass (*Panicum maximum*), while Golden Crown grass and Guatemala grass (*Tripsacum laxum*) have also been in great demand. A brief note on Napier grass appearing in this number indicates that under good management this grass can give yields of over 100 tons per acre and that it will not only provide maintenance and production requirements for cattle in milk, but, with the addition of small quantities of poonac, is quite adequate for working bulls. The writer of the article has calculated that, even if only 50 tons per acre were obtained, one acre of Napier grass would furnish sufficient nourishing fodder throughout the year for production and maintenance requirements of four black cattle in milk.

The need for improving and increasing the food supplies for village cattle is constantly being urged by officers of the Agricultural and Veterinary Departments, and the growing of fodder grasses for this purpose is being demonstrated to villagers on some of the stations of both Departments. Until the villager realises this necessity, but little progress can be made in improving the village breed of cow. As stressed by the Government Veterinary Surgeon in his Administration Report for 1934, the work of improvement of the standard of cattle, not only in respect of their milking capabilities, but also for carting and ploughing, would become much easier if a real demand for milk existed in the villages.

THE AREA UNDER BUDDINGS IN MALAYA

DR. P. J. S. CRAMER,

FORMERLY DIRECTOR OF THE GENERAL EXPERIMENT STATION, BUITENZORG

SINCE we published in *The Tropical Agriculturist* figures on the areas under budgrafted rubber in the Dutch East Indies, we have come across some recent statistics on the budgrafted areas in Malaya (Rubber Statistics Handbook 1935). We need not point out that Malaya is the largest rubber-producing country and has the biggest acreage under rubber. The area under rubber is, in round figures, over 1·5 million acres in the Federated Malay States, whilst the Straits Settlements and Unfederated Malay States account for about the same figure, so that the total area under rubber is well over 3 million acres.

At the end of 1934 out of this total there was an area of 204,691 acres under budded rubber, a percentage of roughly 6·5 per cent. This figure is much lower than the percentage figure for the Dutch East Indies.

Among the various groups of States and territorials, which form Malaya, we find that the Federated Malay States contain more than half the total of the budded area. The figures are:

Budded area at the end of 1934

Perak	13,001 acres
Selangor	31,589 ,,
Negri Sembilan ...	41,174 ,,
Pahang	17,598 ,,
	103,362 ,,

The figures for the Straits Settlements are much lower. For Penang (21 acres) Singapore (10 acres only!) and Province Wellesley (354 acres); the acreage is insignificant; Malacca with 4,012 acres and the Dindings with 3,372 acres make a better show, but the total for the Straits Settlements, 7,769 acres, is even, in proportion to the total acreage under rubber, lower

than for the other groups. Among the three Unfederated Malay States, Johore is leading with 63,930 acres, surpassing even the best figure of the Federated Malay States. Kedah with 25,537 acres also makes a good show, while Kelantan has only 4,093 acres; so that the total for the Unfederated Malay States is 93,560 acres.

The final addition for the area under budgrafted rubber at the end of 1934 is as follows:

Federated Malay States	...	103,362 acres
Straits Settlements	...	7,769 ,,
Unfederated Malay States	...	93,560 ,,
		204,691 ,,

Another table given for each state or province classifies the areas according to the year in which they were established, but these figures do not go further than the end of 1933. Added together for the whole of Malaya we find the following acreages:

1922 (and earlier)	5,051 acres
1923	1,189 ,,
1924	1,066 ,,
1925	476 ,,
1926	1,900 ,,
1927	8,160 ,,
1928	9,452 ,,
1929	29,268 ,,
1930	46,088 ,,
1931	34,207 ,,
1932	27,600 ,,
1933	7,270 ,,
	171,727 acres

We see from these figures that budgrafting was taken up in Malaya as a means of improving rubber planting material at an early stage.

In 1922-23 budgrafting was started on the well-known estate Prang Besar, which has contributed some very good clones to our available planting material. In the following years much of the budding in Malaya was still done with budwood from high-yielding estate trees.

In 1926 we find an increase. In this year the first budwood from the Avros clones in Sumatra was introduced on estates in Malaya and was probably used on several estates for laying out small testing plots; budding with estate clones continued. We thus see a gradual increase, until in 1928 several large groups decided to go in for budgrafting on a large scale. Budwood was imported in large quantities from Java and Sumatra and used for budding in the field plantings of 1, 2 and even 3 years old. Then come the years of large extensions, often still by budding young plantings in the field, the period 1929-1931. It is probable that, had the slump not set in, this development would have gone on, and would have led to a much larger budded area in Malaya.

The extensions of 1932 and 1933 were probably made to a large extent with buddings made in the nursery or, if the budding was carried out in the field, on young plantings already laid out for the purpose. The slump then made itself felt more and more and it reduced budding activities without, however, stopping them altogether.

It will be curious to watch the development in the next years. In 1935, extension of budded areas in the countries adhering to the restriction scheme can only be effected by replanting old fields. Considerable replanting is going on this year in Sumatra; in Malaya it has not been so popular, but now that the restriction authorities have been more lenient on this point and have reduced the cut in the assessment for the replanted area to 110 lb. per acre, we may expect that replanting will be taken up on a much larger scale in 1936.

With replanting, the main object is that we want to increase in our plantings the percentage of improved material. Under the present restriction law 20 per cent. of the total area may be replanted before the end of 1938. That means for the whole of Malaya, with its total area of over 3 million acres, over 600,000 acres. But not all the owners of old plantings of ordinary seedlings will use their rights to replant to the full extent. The native rubber planter, on his small-holding will probably not be able to do much in this line for various reasons, and few even of the European-owned estates will replant the whole acreage to which they are entitled. I think that we cannot expect more than a doubling of the total area under buddings during the restriction period for the whole of Malaya.

Will all the improved material used for replanting be budded rubber ? I do not think so. For replanting, preference goes to seedlings of improved yielding capacity, and if we had already strains of seedlings available of a known, proved yielding capacity equal to that of our best clones, I do not doubt that such seedlings would be used in preference to buddings. But we are not in that position yet. We only know that a few clones — mainly Avros clones — give good seedlings, and that some other clones give poor seedlings. The Avros Station especially has done valuable work in this respect, testing seedlings from various origins. Very little is known of the value of other clonal seedlings. We have seen some figures of the yields of mixtures of clonal seedlings, but what we want to know is: what yields may we expect from seedlings of a certain clone, especially when they come from monoclonal fields of a fair size, so that we are sure that the seeds are practically pure.

In this respect Malaya has a great advantage over Java and Sumatra, in so far that in Malaya most estates have gone in for monoclonal planting. The same can be said of French Indo-China and in both countries, from 1934 on, plantings have been made with seeds from monoclonal fields, which in a couple of years will show us which clones we should choose for our seeds. The great variety of clones used in Malaya — clones developed locally as well as introduced from Java and Sumatra — increases the chance that some exceptionally good strains will be found.

We must also mention a second difficulty with seed planting, and that is that a large number of seeds is required per acre, while the seed crop is sometimes poor — as was, for instance, the case this year in Malaya and Sumatra. It depends upon the system scheduled for thinning out, how many seeds will be used per acre; the number may vary from 5,000 to 500, but it will rarely be under the last mentioned. The seed crop will vary also for the various clones. We have seen an instance where the crop could be estimated at about 25,000-30,000 per acre, and others where one hardly could find a seed pod on the trees.

These factors make it improbable, that seedling planting will be undertaken on a very large scale in Malaya before the end of the present restriction period.

However, that in Malaya a keen interest is taken in the seedling problem may be concluded from the last Annual Report (on 1934) of the Rubber Research Institute, where (on page 65) the Head of the Botanical Division writes:

> "It is, therefore, extremely interesting to record that there is hardly any other subject of investigation in the Botanical Division, which has aroused more interest during the latter half of the year 1934 than the progress of the work on budding and selection of high-yielding seedling trees."

In most of the rubber-producing countries, the planting industry begins to realise that the restriction years should be used for replanting part of the estate with improved material so as to come out of the first restriction period with plantings better armed to keep up competition.

STUDIES ON PADDY CULTIVATION—V

A. THE EFFECT OF TIME OF APPLICATION OF FERTILISER

B. THE EFFECT OF THE FORM OF PHOSPHORIC ACID APPLIED

J. C. HAIGH, PH.D.,

ECONOMIC BOTANIST,

AND

A. W. R. JOACHIM, PH.D.,

AGRICULTURAL CHEMIST,

DEPARTMENT OF AGRICULTURE, CEYLON

IN the first paper of this series* it was determined that the yield of paddy could be increased by the addition of phosphoric acid, with or without ammoniacal nitrogen, but that only 20 to 25 per cent. of the phosphoric acid added to the soil appeared in the plant. It was assumed that the phosphoric acid had been fixed in the soil and had thereafter become available as it was required, but it was not clear whether the absorption was only 25 per cent., because no more than 25 per cent. would ever be available, or because the rate of absorption of phosphoric acid was such that the periods of availability and absorption did not coincide. It was, therefore, considered necessary to apply the fertiliser in such a way as to vary its availability. This was attempted in two ways, (a), in time of application and, (b), in form of phosphoric acid. If a definite percentage of the phosphoric acid added to the soil becomes locked up in an unassimilable form, then the addition of the fertiliser in fractions should make no difference, since the same percentage of each fraction will become available. (When one compares the enormous amounts of iron and aluminium that are present in soil with the insignificant quantities of phosphoric acid added, it is difficult to avoid the conclusion that the whole supply is immediately transformed into insoluble alumino-ferro-phosphatic

* *The Tropical Agriculturist*, Vol. LXXXI, July, 1933, p. 3.

compounds). If, on the other hand, the rate of absorption is such that the absorption of all the available fertiliser does not coincide with the plant's period of root activity, then a differential effect may be hoped for by adding the fertiliser in fractions. Considering the form of phosphoric acid supplied, it is known that different forms of phosphoric acid have different reactions in the soil, and may, therefore, be expected to become available at different rates.

A. THE EFFECT OF TIME OF APPLICATION OF THE FERTILISER

The fertiliser was applied in the form of ammonium phosphate to a transplanted crop growing in 1/100-acre plots with borders. There were six replications, randomised, and the treatments were: (a) fertiliser applied in a single dose just before transplanting, (b) the same quantity of fertiliser applied in two doses, one before transplanting and one before flowering, and (c), the same quantity applied in three doses, one before transplanting, one before flowering and one at half ripeness. The series was duplicated, one with narrow ratio ammonium phosphate and one with wide ratio, so that there were six treatments in all. The rate of application was 87·2 lb. per acre for the narrow ratio phosphate and 1 cwt. per acre for the broad ratio, so that each plot received the same amount of nitrogen per acre. The experiment was carried out during the *Maha* 1933-34 season and the paddy used was Mawi B-11.

The results of the experiment will be found in table I. They indicate that it is immaterial, as far as the effect on yield is concerned, whether the fertiliser is applied in one dose or in three. A second crop was grown in *Yala* 1934 for the observation of residual effect. The results are given in table II and, as might be expected, show no significant differences. It was found necessary to abandon replication *a* on account of very severe damage by crabs (*Paratelphusa* (*Oziotelphusa*) *hydrodromus* Herbst.

It also appears to be immaterial whether broad or narrow phosphate is used. It should be remembered, however, that the fields used in the trial are at least of average fertility, and that a similar experiment carried out on a poor field would probably give a result in favour of the broad ratio fertiliser.

The full chemical data will be presented separately in paper VI of this series and it is only necessary here to comment on the general results.

The percentages of fertiliser constituents in the crops are rather higher than in previous seasons, particularly those of phosphoric acid. This may be connected in some way with the larger dose of manure given in this trial. The composition of the differently-treated crops shows no marked or consistent variation, and the general observations are similar to those made previously.

The average rates of absorption of nitrogen and phosphoric acid during *Maha* are similar to those obtained in previous experiments with transplanted crops. The corresponding figures for *Yala*, however, are considerably higher than in previous seasons. The rates of absorption vary in the different treatments, but not consistently, nor with any reference to yield. The period between sowing and flowering varied with treatment and this variation will account, at least in part, for the variation in rate of absorption. The relative distribution of fertilising constituents throughout the plant is the same as that found in previous experiments.

The average amounts of fertilising constituents removed in the crop in lb. per acre are as follows:

	Nitrogen	Phosphoric acid
Maha 1933-34	49·5	23·4
Yala 1934	24·1	9·2
	73·6	32·6

The amounts are considerably higher than those recorded for previous experiments, but it must be noted that yields in general are also higher, there are no control plots to lower the average, and the percentage composition of the crop shows a higher proportion of nitrogen and phosphoric acid.

There are no appreciable differences in the amounts of fertiliser removed by the different treatments. The average total amounts of nitrogen removed from the narrow-and wide-ratio plots are respectively 74 and 73·2 lb. and are almost identical. These results are in agreement with the treatments, which gave equal quantities of nitrogen per acre to the two series. The corresponding figures for phosphoric acid are 30·4 and 34·8 lb.

Thus only about 4·5 lb. per acre more of phosphoric acid has been absorbed by the wide ratio crops, although 27·9 lb. per acre more were applied to the soil. This result, combined with the absence of significant differences in yield between the crops treated with the two types of ammonium phosphate, suggests that the use of the more expensive wide ratio ammonium phosphate over the narrow, even on good fields, is not justified. It would be rash, however, to give up the use of this fertilizer as the result of one trial.

B. THE EFFECT OF THE FORM OF PHOSPHORIC ACID USED

Phosphoric acid was applied in four forms—as ammonium phosphate, as steamed bone meal, as superphosphate and as a mineral phosphate. The standard rate was that of the narrow ratio ammonium phosphate used in the first series, viz., 87·2 lb. per acre, and the other forms were applied at such rates that each plot received the same amount of nitrogen and phosphoric acid per acre, the extra nitrogen being added in the form of sulphate of ammonia. The experiment was carried out as before in 1/100-acre plots with borders, randomised and replicated six times, and the fertiliser was applied just before transplanting. The paddy used was Mawi B-11.

The results of the trial are found in table III and indicate no significant difference between treatments. It will be noted that the yield from the plots treated with ammonium phosphate approximates very closely to that from the corresponding treatment in the other series.

A second crop was grown in *Yala* 1934 for the observation of residual effects, but no significant differences were found (table IV).

The general conclusions to be drawn from the chemical data are very similar to those drawn for the first series. The average amounts of fertilising constituents removed by the crop in lb. per acre are as follows:

	Nitrogen	Phosphoric acid
Maha 1933-34	44·3	21·2
Yala 1934	18·4	6·0
	62·7	27·2

The ratio between these quantities and the corresponding ones for the other series is the same as that between the yields in the two series, and the same explanation of their high value is offered.

The addition of phosphoric acid in the quantities used in this experiment has not produced any appreciable difference in the amount of "chemically available" phosphoric acid found in the soil. This fact, together with the presence of equivalent amounts of available nitrogen, probably accounts for the non-significance of the yield differences between treatments. The non-significance of the *Yala* differences further suggests that, for the quantities applied, steamed bone meal has no more lasting effect than ammonium phosphate.

CONCLUSIONS

Nitrogen and phosphoric acid have been supplied to transplanted paddy at Peradeniya in quantities equivalent to one hundredweight of broad ratio ammonium phosphate per acre. It appears to make no difference to the final yield whether the fertiliser is added in one large dose at the beginning of the season, or in several smaller doses spread over the growing period. It also appears to be immaterial in what form the phosphoric acid is applied, whether as the readily assimilable ammonium phosphate or the so-called "slow-acting" steamed bone meal.

TABLE I

PERADENIYA PADDY SEED STATION

MAHA 1933-34

Manurial Trial on 1/100-acre plots

Treatment	Replications Yield in lb.						Total	Mean	M=100	Bushels per acre
	a	b	c	d	e	f				
One application narrow ratio	34·31	37·69	37·00	34·06	37·00	24·25	204·31	34·05	103·7	70·9
Two applications narrow ratio	37·44	30·19	37·37	25·56	34·62	25·37	190·55	31·76	96·7	66·2
Three applications narrow ratio	37·00	36·25	29·69	30·44	26·06	27·69	187·13	31·19	94·9	65·0
One application broad ratio	34·44	41·69	32·12	25·50	37·75	19·50	191·00	31·83	96·9	66·3
Two applications broad ratio	34·25	38·12	35·81	28·19	33·37	28·75	198·49	33·08	100·4	68·9
Three applications broad ratio	35·37	42·50	39·62	29·87	40·25	23·75	211·36	35·23	107·2	73·6
	212·81	226·44	211·61	173·62	209·05	149·31	1182·84	32·86	100	68·5

z is not significant: standard deviation of 6 plots is 8·9 lb.

TABLE II

PERADENIYA PADDY SEED STATION

YALA 1934

Manurial Trial on 1/100-acre plots

Residual effects

Treatment	Replications Yield in lb.					Total	Mean	M = 100	Bushels per acre
	b	c	d	e	f				
One application narrow ratio	16·19	18·00	13·62	17·31	13·25	78·37	15·67	95·1	32·6
Two applications narrow ratio	18·37	19·75	18·25	20·37	15·94	92·68	18·54	112·6	38·5
Three applications narrow ratio	19·87	14·87	13·69	15·19	17·87	81·49	16·30	98·9	33·9
One application broad ratio	23·19	16·00	13·81	14·37	13·00	80·37	16·07	97·6	33·5
Two applications broad ratio	15·50	15·87	12·37	17·37	16·69	77·80	15·56	94·4	32·4
Three applications broad ratio	18·62	17·87	12·44	18 87	15·50	83·30	16·66	101·2	34·7
	111·74	102·36	84·18	103·48	92·25	494·01	16·47	100	34·3

z is not significant: standard deviation of 5 plots is 4·8 lb.

TABLE III

PERADENIYA PADDY SEED STATION

MAHA 1933-34

Manurial Trial on 1/100-acre plots.

Treatment	Replications / Yield in lb.						Total	Mean	M = 100	Bushels per acre
	a	b	c	d	e	f				
Steamed bone meal + Sulphate of Ammonia	37·50	39·00	30·00	31·81	36·37	32·06	206·74	34·46	108·5	71·8
Ammonium phosphate	37·50	28·56	28·50	32·19	33·87	35·56	196·18	32·70	103·0	68·1
Mineral phosphate + Sulphate of Ammonia	36·81	23·62	28·00	29·31	28·31	33·75	179·80	29·97	94·4	62·4
Superphosphate + Sulphate of Ammonia	25·62	33·31	26·19	27·00	32·44	34·50	179·06	29·84	94·0	62·2
	137·43	124·49	112·69	120·31	130·99	135·87	761·78	31·74	100	66·1

All plots received nitrogen and phosphoric acid at the rate of 15·7 lb. per acre.

z is not significant: standard deviation of 6 plots is 9·1 lb.

TABLE IV

PERADENIYA PADDY SEED STATION

YALA 1934

Manurial Trial on 1/100-acre plots

Residual effects

Treatment	Replications			Yield in lb.			Total	Mean	M = 100	Bushels per acre
	a	b	c	d	e	f				
Steamed bone meal + Sulphate of Ammonia	13·87	3·25	13·87	13·50	16·50	8·75	69·74	11·62	98·8	24·2
Ammonium Phosphate	7·19	8·75	13·62	16·37	9·06	11·50	66·49	11·08	94·2	23·1
Mineral Phosphate + Sulphate of Ammonia	9·75	11·94	13·25	12·25	7·69	12·87	67·75	11·29	96·0	23·5
Superphosphate + Sulphate of Ammonia	10·31	11·06	13·87	14·00	15·44	13·56	78·24	13·04	110·9	27·2
	41·12	35·00	54·61	56·12	48·69	46·68	282·22	11·76	100	24·5

z is not significant : standard deviation of 6 plots is 8·6 lb.

The low yields in replication *b* are due to a serious attack of crabs :
if this replication be omitted, the deviation due to external factors is still greater than that due to treatment.

NAPIER GRASS AS A CATTLE FODDER AT PERADENIYA

L. LORD. M.A. (OXON.)

THE provision of ample supplies of cheap and palatable fodder for cattle is a wide-spread problem in Ceylon which appears to have been solved at Peradeniya by the growing of Napier grass. Napier or Elephant grass, botanically known as *Pennisetum purpureum*, was introduced on the Experiment Station, Peradeniya, in 1922 from Manila. As early as 1908 the growing of *P. purpureum* grass was advocated by a Colonel Napier in Rhodesia by whose name it is now known in many parts of the tropics. In his account of fodder grass trials at Peradeniya, Holland* stated that the grass by 1929 had already achieved considerable popularity but the figures of yields given by him are not only on the low side but compare unfavourably with those of Guinea grass "B" which on the evidence then available was considered the best fodder grass for Peradeniya conditions. In the unreplicated plot trials carried out at Peradeniya between 1921 and 1928 the mean yield of Napier grass was 18·8 tons per acre while that of Guinea grass "B" was 23·7 tons These yields, although providing sufficient evidence as to the utility of these grasses, gave no indication of the tremendous possibilities of Napier grass. Owing to the lack of general interest in the cultivation of fodder grasses, trials were discontinued on the Experiment Station, Peradeniya, until 1934 when small (1/80th-acre) plots were planted with various fodder grasses chiefly for the benefit of the Farm School students and visitors to the Station. Most of these plots have now been cut (at first every two months but since May, 1935, every month) for one year and the results, which follow, are of considerable interest.

Yields of Fodder Grasses (Green material)

Grass	Date of Planting		Yield per acre Tons	cwt.
Napier	16.6.34	...	117	5
Merker's	20.10.34	...	86	18
Guinea "B"	20.10.34	...	69	—
Guinea "A"	13.6.34	...	68	19
Guatemala	20.10.34	...	50	14
Buffalo	20.10.34	...	35	3

* Fodder grass trials on the Experiment Station, Peradeniya, Dept. of Agric. Ceylon, Bul. 84, 1929.

The plots were not manured after planting until September, 1935, when each plot received 400 lb. compost and 1 lb. sulphate of ammonia. Little reliance can, of course, be placed on the comparative yields of unreplicated plots and too much importance must not be ascribed to any individual yield but it has certainly been demonstrated that under suitable management Napier grass at Peradeniya is capable of producing extremely high yields. Napier grass has produced both high and regular yields and the green grass obtained from the last four cuttings was: 246 lb., 234 lb., 289 lb., and 214 lb., (from 1 80th-acre). These high and regular yields were obtained with a below normal rainfall of under 20 inches for the four months. It will be seen that this combination of high and regular yield of palatable grass makes Napier grass extremely valuable in cattle feeding. An analysis of Napier grass cut monthly (kindly made for the writer by the Acting Agricultural Chemist) shows a crude protein content of 1·76 per cent. (of the fresh material) with a dry matter content of 14·39 per cent. This compares unfavourably with the 3·5 per cent. of crude protein in English pasture grass, but is higher than the amount (1·5 per cent.) found in Napier grass in Trinidad.*

Digestibility trials are necessary to determine its precise value, but there is little doubt that Napier grass alone will meet the maintenance and production requirements of good village cows yielding up to four pints of milk per day. For working bulls it will almost certainly be advisable to give in addition a pound or two of poonac. On the Experiment Station working bulls and cows in milk are being fed 60-70 lb. of grass per day. This is readily eaten and more would be eaten if supplied. Additional areas of Napier grass have recently been planted and when these come into full bearing it is proposed to increase the ration of grass for working bulls to 80-100 lb. per day and reduce the amount of poonac from 3 lb. to 1 lb. The value of Napier grass may be realised by drawing attention to the fact that if a yield of only 50 tons per acre is obtained (less than half the yield obtained at Peradeniya) one acre of the grass will produce throughout the year sufficient fodder for the production and maintenance requirements of four black cattle in milk.

* The Influence of Time of Cutting on the Growth, Yield and Composition of Tropical Fodder grasses, I. Elephant grass (*Pennisetum purpureum*) D. D. Paterson. Jour Agric. Sci. 23.4.1933.

The Trinidad trials quoted above show that the frequency of cutting Napier grass affects the yield, the percentage of dry matter and the crude protein content of the grass. The grass was cut at three intervals: monthly, once in two months and once in three months, and it was shown that the total yield and percentage of dry matter increased and the percentage of crude protein decreased with less frequent cuttings. At Peradeniya three months old Napier grass contains thick stalks which are not eaten by cattle and it would appear advisable, until further trials have been carried out, to cut the grass before the thick stalks develop and at a time when the protein percentage is moderately high.

Two fodder grass trials have recently been laid down at Peradeniya to determine (i) the relative yielding capacities of Napier grass, Merker's grass, Guatemala grass and Guinea grass "B" and (ii) the effect of cutting monthly, once in six weeks and once in two months.

THE CULTIVATION AND MANAGEMENT OF NAPIER GRASS

The following notes are added for those who wish to grow this grass. The grass is propagated by stem cuttings taken from mature plants. These cuttings are from 12 to 18 inches long and contain from two to three nodes. They may be obtained from the Experiment Station, Peradeniya at a cost of Rs. 3·25 per 1000. The cuttings should be planted as soon as received on land which has been ploughed or dug over and cleaned of weeds. An application of one or two tons per acre of farmyard manure or compost is recommended; 1 to 2 cwt. of sulphate of ammonia or Nicifos No. 2 may be applied instead or, if heavy yields are desired, in addition. A suitable planting distance is 2 ft. $\times$ 2 ft. and it facilitates later weeding and manuring if the cuttings run in lines at least in one direction. The cuttings should be planted at an angle of about 45° and with half or a little more than half of the cutting below ground. Unless the soil is very friable a hole should be made for the cutting by means of a mammoty. After planting the soil should be consolidated round the cutting.

In about 6 to 8 weeks the young growth should be cut for the first time to encourage bunching and afterwards the plot should be weeded. From now on cutting should be carried out

every 4 to 8 weeks according to the growth of the plants. The plants should be yielding heavily six months after planting and thenceforward the manuring previously recommended should be repeated twice a year. Heavier and more frequent manuring may also be given.

In spite of its luxuriant growth Napier grass will not completely keep down weeds and periodic weedings are necessary. Manures when given can conveniently be applied just after one of the cuttings.

Napier grass is particularly successful at Peradeniya at a mean elevation of 1,550 feet and with an average annual rainfall of about 89 inches, but good results have also been obtained in places both higher and lower than Peradeniya and the grass is well worthy of a trial in most parts of Ceylon. The writer will be glad to hear from anyone in Ceylon who has grown Napier grass successfully under different climatic conditions from those of Peradeniya.

TOMATO CULTIVATION IN THE DRY ZONE OF CEYLON—I

W. R. C. PAUL, M.A., M.S.C., D.I.C., F.L.S.,
DIVISIONAL AGRICULTURAL OFFICER, NORTHERN

INTRODUCTION

WITHIN recent years there has been a growing interest taken in the production of tomatoes, particularly from the dry zone areas of Ceylon where conditions for the cultivation of this crop are generally more favourable than elsewhere in the Island.

The popularity of the tomato may be largely ascribed to its particular flavour and attractiveness as a slicing vegetable as well as to the increasing recognition of its nutritive value. It is now widely regarded as one of the most esteemed table vegetables and according to Carver (1918) can be prepared in 115 different ways, both raw and cooked. For canning and the manufacture of various tomato products it is pre-eminently suitable and ranks first amongst the vegetable canned crops of the United States.

In food value, tomatoes have recently come into much prominence. They are found to be particularly rich in mineral salts such as phosphates and potash though deficient in calcium They have a high percentage of moisture in all stages of the fruit and their fibre content is low, making them easily digestible. As a source of vitamins they are invaluable; the ripe fruits have been found to contain relatively large quantities of vitamins A, B, and C and experiments carried out in U. S. A. have shown that the fruits which are allowed to remain on the plant until they are ripe are higher in vitamin C than those which are picked green and ripened in storage. It is of note that the vitamins in tomatoes are almost unchanged by cooking or by treatment with ethylene gas for the artificial colouring of unripe fruits. Furthermore, the canned ripe fruits and preserved juice manufactured according to modern processes are almost as rich in their vitamin content as the fresh ripe fruit. The importance of tomatoes as a result of their richness in vitamins in the diet of the peasant

population that are ill-nourished in the malarial districts of Ceylon cannot be overestimated. The vitality and general resistance of the people are increased and malarial infection is thereby greatly reduced.

In many temperate countries, tomatoes are regarded as one of the chief vegetable crops and are intensively raised in glass houses, as a farm crop in the field, in market and in home gardens for the following purposes: 1. Local markets. 2. Export 3. Canning and manufacturing. 4. Seed production.

In the tropics, however, the crop is relegated to a comparatively minor position and is mainly produced in peasant allotments and home gardens for sale in local markets. It is, however, proving increasingly attractive even in districts of limited markets and, in comparison with most other annual crops grown in the tropics, the yields and return per acre are high. But unless wider markets can be secured there is a danger of overproduction and consequent wastage owing to the perishable nature of the fruit.

The increase in the demand for tomatoes and the improvements that have taken place within recent years in the methods of growing and marketing the crop have made it possible to extend its markets especially from the more remote areas of production and to export it to other districts and countries particularly during seasons of shortage and favourable prices. In the export overseas of tropically grown tomatoes considerable success has been achieved by the smaller British West Indian islands which by reason of a preferential tariff are able to export their tomatoes to Canada during the winter months. In Ceylon, efforts are being made to grow tomatoes in the dry zone for marketing in Colombo. The main difficulty at present lies in the lack of a marketing organisation which can carry out the grading, packing and transport arrangements of the crop.

Apart from growing tomatoes in this way for local and export markets of fresh fruits, the possibilities of canning and of manufacturing sauces, juices and other products require investigation. There is an increasing demand for these products in Ceylon and considerable quantities are at present being imported.

As regards seed production, little or no work has been done in the tropics to produce varieties or strains that are acclimatised or suited to local conditions. It is becoming increasingly evident

that there are strains which are more adapted than others to particular localities which show differences of soil and climate. At present, nearly all the better grade varieties of tomatoes under cultivation are from seed imported from temperate regions and particularly from U. S. A. There is, therefore, much scope for the development of improved varieties or strains that are well adapted to particular areas.

It is of importance that before undertaking an extensive cultivation of tomatoes, the grower must assure himself of a profitable outlet for his crop. He must have a good local market or be in proximity to a manufacturing centre or have facilities for exporting his crop. It does not generally pay to cultivate tomatoes for distant markets except on an acreage sufficiently large to cover freight expenses unless groups or associations of small growers can be formed for pooling their produce before despatch. Tomatoes are generally an intensively raised crop needing much care and attention during the entire season of their growth. The cost of production is, therefore, high and the areas cultivated by individual growers are thus necessarily limited. The crop is also very susceptible to disease, especially under unfavourable weather conditions, such as prolonged wet weather or high temperatures. But the yields are generally large and, with fair prices, high profits can be made. The cultural practices, however, greatly determine the quantity and quality of the crop produced and in many parts of the dry zone tomatoes as grown by peasants do not receive the attention necessary for high yield and good quality. Under intensive methods of cultivation in areas suited to the growing of this crop and with seeds of superior varieties, larger yields can be obtained, but though the total expenditure per acre is greater the net returns are much better.

Very little information seems to be available in regard to the improvement of tomato growing in the tropics and much investigation is needed on questions of yield, varieties, systems of cultivation, seasons for planting, grading, packing etc., in order that the crop may be grown more remuneratively for the particular markets in view. Paterson (1931) has drawn up some preliminary suggestions for laying down modern field experiments on tomato cultivation in the West Indies. Many of these suggestions could well be taken up for investigation in other parts of the tropics so that more information may be gained on

various aspects of tomato cultivation from properly controlled experiments, which with modern field technique would indicate the reliability of the results by valid statistical methods.

In view of the increasing interest now being taken in this crop in Ceylon, the object of this paper is to give a detailed account of the methods of cultivation of tomatoes based on the available information. Much of this, however, is compiled from data obtained from work originally carried out in U. S. A. where such results were found applicable to Ceylon conditions.

CLIMATE

The tomato plant requires a comparatively warm and sunny climate with a light rainfall. In the tropics the rainfall is the chief factor determining the success of tomato cultivation and areas with a total annual rainfall of over 75 inches are not very satisfactory for the extensive cultivation of this crop. The dry zone areas with an annual rainfall of 40 to 60 inches have proved most suitable. During the growing period of the crop which takes about $1\frac{1}{2}$ to 2 months there should be a uniform but not too heavy rainfall and when development and ripening of the fruits take place a dry season with occasional light showers should prevail. In areas of high humidity vegetative growth becomes very marked while fruit development is poor and diseases of both the vines and fruits are excessive. The fruit is also more watery and lacking in flavour when grown during periods of wet weather. It is for these reasons that the crop does best in the dry zone and is planted during the North-East monsoon so that fruiting and ripening takes place in dry weather.

In order to avoid the effect of excessive rains, planting out in the field may be carried out towards the latter end of the monsoon but it may be necessary to resort to irrigation for a short period after the monsoon rains have ceased. In light soils, however, with good drainage planting out can be done with the commencement of the monsoon.

Tomatoes thrive best in a day temperature of 65° to 85°F. Nightingale (1933) has shown that the optimun temperature for vegetative growth is 70°F. but this is somewhat lower than the average which prevails in the dry zone. In a cooler but dry climate such as at Bangalore in South India tomatoes do exceptionally well.

When temperatures are high and moisture in the soil deficient irrigation should be resorted to as otherwise these conditions led to dropping of the flowers and blossom-end rot of the fruits. During the fruiting period there should be plenty of sunshine, cloudy weather being not conducive to the production of good quality fruits. Miss Pfeiffer (1926) found that with 12 hours of light daily the greatest growth was made, while with only 5 to 7 hours' light growth was poor and with 17 hours or more the plants were injured and finally killed. The splendid colour shown by the Italian grown tomatoes in comparison with other temperate grown tomatoes is attributed largely to the amount of sunshine rather than to any superior varieties of cultural practices.

In table I the meteorological data* for two stations in the dry zone are given.

Wind is an important factor in tomato cultivation. The crop cannot be grown successfully in wind blown areas and hot dry winds especially cause dropping of the flowers. It is always necessary to plant tomatoes in sheltered situations or to have wind belts established. Efforts to grow the crop during the dry season when the south-west winds are strong in the dry zone, in spite of irrigation and a certain degree of wind protection have so far not proved very successful. All three factors during that season—strong wind, dry weather and high temperature—militate against success.

VARIETIES

There is a large number of varieties of tomatoes which differ in shape, size, colour and flavour of the fruit as well as in several other characters, such as yield, maturity, etc. Unfortunately scores of varietal names, many of which are misleading and others show no differences of varietal significance, have been given from time to time by seedsmen and growers. There has been a general lack of authentic descriptions of varieties and conseqently considerable confusion has arisen as to the characters by which particular varieties may be distinguished and whether such characters are of sufficient varietal value. This need for the standardisation of varieties has been realised by the United States Department of Agriculture (1933) which has published a description of nine principal American varieties of tomatoes cultivated in the States.

* Figures kindly supplied by the Superintendent, Colombo Observatory.

TABLE I

Anuradhapura	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
Mean Rainfall (in inches)	3·97	1·58	2·91	6·87	3·57	1·22	1·25	1·74	3·11	9·72	10·70	8·62	55·28
Mean Temperature F°	75·9	77·9	81·1	83·0	82·5	82·5	83·0	83·2	82·6	80·8	78·7	76·4	80·6
Mean Maximum Temp. F°	82·0	86·3	90·5	91·2	89·2	88·8	90·3	91·1	90·4	88·1	85·5	83·1	88·0
Mean Minimum Temp. F°	69·8	69·5	71·6	74·7	75·8	76·2	75·7	75·2	74·8	73·4	71·8	69·6	73·2
Jaffna													
Mean Rainfall (in inches)	2·91	1·25	1·15	2·08	1·83	0·61	0·84	1·47	2·79	9·43	14·94	10·57	49·86
Mean Temperature F°	77·5	78·5	81·6	84·5	84·4	83·5	82·7	82·0	82·1	81·0	79·1	77·3	81·2
Mean Maximum Temp. F°	82·7	85·5	88·3	89·3	87·6	86·3	85·9	85·4	85·5	84·9	83·5	82·2	85·6
Mean Minimum Temp. F°	72·3	71·4	74·8	79·7	81·1	80·6	79·4	78·5	78·6	77·1	74·6	72·4	76·7

The tomato plant is capable of great adaptability to its environment and there are differences often shown by a variety which are not large enough to justify a separate varietial name but are sufficiently constant to be regarded as belonging to a different strain. Various strains of the same variety might for example exhibit differences in resistance to a particular disease or in yielding capacity. It is highly desirable that such differences in a variety, while being of value, should not be confused by causing its separation into further varieties. Seedsmen are often tempted to place on the market new strains to which new varietal names are given by them, but if, on the other hand, they endeavoured to meet the demands for the various standard varieties, with whose merits growers are familiar, by supplying better strains of these varieties their reputation would be enhanced. The breeding of new varieties, however, should go uninterruptedly, but seedsmen should not place on the market varieties with new names unless they are really different and superior to those existing.

The modern varieties are a great improvement on the old, flat, angled and furrowed type of fruit which was small in size and of a somewhat acid flavour. This type is still to be seen in cultivation in Ceylon as the 'country' variety and is mainly grown by villagers from their own seed. It is in the temperate countries that the tomato has reached a high degree of perfection, the improved modern variety being a round, solid and smooth—as opposed to furrowed—fruit with a very slightly acid to sweet, juicy flavour. Several of the imported varieties tried in Ceylon under good methods of cultivation come fairly true to type and it is now almost the general custom for the better growers to import their seed regularly. The American varieties have so far proved to be superior both in quality and yield and are more extensively grown in Ceylon.

The varieties of tomatoes can be mainly separated according to Friend (1933) into the following three classes based on the shape of the fruit which is an important character from the commercial standpoint:

A. Flattened

B. Flattened globular

C. Round or globular

On this basis, some of the well-known American varieties are classified below:

A. Ponderosa, Santa Clara, Earliana (older strains)

B. Bonny Best, Stone, Earliana (newer strains)

C. Marglobe, Globe

The flattened types have generally larger sized fruits but there is a much greater tendency to irregularity in shape than with the other two types, the globular showing the most uniformity. From the commercial standpoint not only is the shape of the fruit important but also its uniformity. A variety which shows much variation in the shape of its fruit does not command the same value as one whose fruit is more uniform. There is, however, a certain degree of variation in the shape of the fruit produced from each particular variety, and under unfavourable conditions of soil and climate these variations may be more pronounced. It has been pointed out by the United States Department of Agriculture (1933) that when vegetative growth is excessive the fruits tend to be flatter, while in the case of restricted vegetative growth they become deeper and more globular. Many varieties differ in their degree of variability and there is also the question of variations between strains of the same variety. Balch (1933) has found that seed obtained from different sources under the same varietal name did not always produce the same type of fruit even when grown under similar conditions and it is possible that in this case different strains showing variability in fruit shape were used.

The extent or irregularity in shape was determined by Friend (1933) in a number of varieties and strains tested by him. Where less than 60 per cent. of the crop failed to conform to the varietal type the strain was designated by him as being 'very irregular', where less than 70 per cent. but more than 60 per cent. as 'irregular' and where more than 70 per cent, as 'regular'. Thus varieties can not only be classified according to their fruit shape but also to the extent of variability shown in their shape. In a test on three varieties, Red Rock, Bonny Best and Marglobe, Paul (1934) found that Marglobe showed least variability in shape. The globe types have generally shown the most uniformity while the flattened the least. The marked irregularity of a flattened variety like Ponderosa is familiar to many growers of this variety.

The globe types are generally the smoothest, while the flattened types show the greatest tendency to furrowing. Even in improved varieties like Bonny Best there is a slight degree of furrowing shown at the stem end of the fruit and this lowers the value of the fruit for table purposes in comparison with a fully smooth variety as in slicing a certain wastage marked in the older and degenerate varieties of tomatoes.

As regards size of fruit the effect of environment is well known. A poor soil or unfavourable climate causes the fruits to be small while when conditions for growth and production of fruits are ideal the maximum size of the particular variety will result. There is, however, some variation within certain limits under moderately good conditions for each variety. Some of the flattened varieties like Ponderosa have a larger size of fruits than the Globe, but against this there is a greater tendency to irregularity of shape as previously stated. From the commercial standpoint both size and regularity of shape of fruits are important and medium sized fruits of uniform shape are preferable to those that are large but irregularly shaped. It is for this reason that the Globe or round types are considered best.

Most modern varieties have a deep red colour of fruit and a preference is now shown for this colour to the pink, pomegranate, purple or yellow-skinned varieties.

Yield from the grower's point of view is the chief factor determining the success of tomato cultivation. Considerable variation in yields amongst different varieties has been reported by American workers and the numerous tests that have been carried out have been useful in eliminating the obviously poor yielders which have gradually been superseded by new and improved varieties amongst which only slight differences in yield exist.

Constancy of yield in a variety is a desirable character but environment may considerably affect this character as the tomato plant is very susceptible to unfavourable conditions of soil and climate as previously indicated. But under good conditions it may be assumed that amongst the improved varieties yield does not play an important part or in other words one variety is almost as good as another from the yield standpoint. Most of the yield experiments, however, that have been carried out in the past with tomatoes have generally not been laid down along modern statistical lines so that the results cannot be considered

as statistically reliable. There is need for more yield experiments of varieties to be conducted with the present-day field technique and also over a sufficient period of time—at least three seasons—to eliminate seasonal conditions which may act differently on the varieties or strains under test.

In temperate countries an important consideration is paid to earliness because when the growing season is short late varieties may be killed by frost. In the tropics, however, earliness is desirable in areas where owing to heavy rains planting out is delayed and irrigation facilities are not available.

An enumeration of all the desirable characters in a tomato grown for table purposes is made below:

(1) Round and regular shape, (2) Large to medium size (3) Bright red colour, (4) Smooth skin, (5) Good flavour, (6) Heavy yielder, (7) Early ripening, (8) Good storage quality, (9) Solid flesh, (10) Hardiness, (11) Disease resistance.

The following is a list of some of the imported varieties chiefly American which have been found to do well in Ceylon: Marglobe, Bonny Best, Stone, Earliana, Ponderosa and Mikado.

(*to be continued*)

IMPERIAL BOTANICAL CONFERENCE*

THE Impeiral Botanical Conference which met on August 27-30 in the rooms of the Linnean Society, Burlington House, London, is the third of a series which dates from the years immediately following the War. At that time, the International Botanical Congresses, initiated in pre-War years, which were due to be held at five-yearly intervals, were in abeyance. Thanks to the efforts of a committee of British botanists a conference of Empire botanists, on a scale fairly comparable to that of an International Congress, was arranged for the year 1924, and took place in London. Quite apart from its value to scientific botany generally and to the advancement of botanical study within the Empire in particular, that Conference undoubtedly acted as stimulus to the resumption of normal friendly relations between European botanists which had been sadly interrupted.

Now that the International Congresses are again established—first at Ithaca, N.Y., in 1926, then at Cambridge in 1930, and in the present year at Amsterdam—the need for Imperial Conferences has to some extent disappeared, at least from the point of view of general botanical science. It was felt, however, that such conferences would still serve a useful purpose in relation to problems of special Imperial interest, to the organisation of research, and not least to the formation of contacts between widely scattered groups of workers. A small Committee was therefore kept in being. A short conference, of a purely formal nature, was held in 1930, and now the third of the series has taken place. The subjects for discussion were limited to those of general economic interest to the Empire, and were in the main suggested by botanists overseas.

In his address of welcome to members, the President, Sir Arthur Hill, emphasised the ever-increasing importance of botanical research in the development of Imperial agricultural resources, not merely with regard to crops which figure in export trade, but also to the food plants of the native and his animals. The study of native crops with the view of obtaining maximum yields under the various local conditions is a work of the greatest national importance which calls for the continued co-operation of botanical and agricultural workers at home and overseas.

PASTURE RESEARCH

Prof. R. G. Stapledon, in introducing a series of papers on "Pasture Research within the Empire," dealt with the importance of 'strain' in pasture plants. Studies at Aberystwyth have abundantly shown that grassland plants are no exception to the general rule that botanical species contain within their ambit a more or less indefinite number of strains or varieties. Between the strains of a particular grass or clover there might be a greater difference in agricultural value, for example, permanence in the pasture, feeding value, economic return, etc.—than there is

* From *Nature*, No. 3436, Vol. 136, 7th September, 1935.

between desirable and undesirable species. These trains or groups of strains have been evolved on a geographical basis, partly in response to climatic and soil conditions, but probably to a large extent as a result of long-continued farming practices. The work of the plant breeder is in the first place to discover which are the most desirable of these local groups for special purposes, and then to ensure that in commercial exploitation any tendency to deterioration is effectively checked. The sowing out of pure strains is not desirable inasmuch as a certain degree of variability gives some insurance against the vagaries of climate and of farming practice. The maintenance of pure strains, with subsequent judicious blending, is a splendid ideal which is very difficult to achieve and is in fact not necessary. The difficulty of maintaining the quality of a certain group of strains ('ecogroup') is not so great as is sometimes imagined and can be overcome for all practical purposes if the work is carried out in a suitable locality and on a large enough scale. The essential point is to safeguard the quality of the original stock, and this can only be done under the direct control of the plant breeding station.

The problems involved in the improvement of pastures in the Dominions were outlined by Dr. I. B. Pole-Evans for the Union of South Africa, and by Prof. G. W. Scarth and Mr. H. J. Whyte for eastern Canada. Dr. Pole-Evans described the natural pasture areas of the Union, and in this connexion exhibited a comprehensive series of coloured plates illustrative of the South African flora. Much damage to natural pastures has already been done by indiscriminate grazing, by burning and by other malpractices. This he ascribed to a general absence of fundamental knowledge relating to the problems of veld management. He reviewed the research work which has been carried out in the Union up to the present and stated that a national research programme has now been organised which will deal in particular with problems relating to the general decline in the carrying capacity of the veld due to faulty grazing methods. This programme will also aim at the building up of an organised animal industry based on the development of the natural pasture potentialities of the country.

In presenting the Canadian problems, Prof. Scarth pointed out that the natural pastures of eastern Canada are at the moment the most important in the Dominion, inasmuch as they carry more than half of the total livestock. A striking feature is that though these pastures have never been ploughed, the significant part of the herbage consists of introduced European plants which have in course of time colonised these areas. The pastures are generally poor and the trend is towards further deterioration. A very comprehensive programme of research, organised both on a Federal and on a State basis, is now being carried out, involving ecological mapping in association with soil surveys, manurial trials in relation to quantity of herbage and to stock rearing or milk production, biochemical studies of pasture plants, etc. The main result so far established is that the pastures as a rule respond markedly to the addition of phosphatic fertilisers, the poor type of *Agrostis* sward being replaced in time by the

better grasses with clovers. The formulation of recommendations applicable to the different soils and climates will only be possible after vigorous research over many years. An ecological study of certain pastures of eastern Canada was presented by Mr. H. J. Whyte and served to illustrate the poor quality of many of these and the need for improvement.

Certain detailed aspects of pasture research in England were described by Mr. G. E. Blackman and by Mr. Martin Jones of the Jealotts Hill Research Station of Imperial Chemical Industries, Ltd. Mr. Blackman showed that under spring conditions, nitrogenous manuring stimulates growth within a certain temperature range only. During midseason, water supply rather than nitrogen is the controlling factor. The effect of light on the growth of pasture plants is complex, varying with the species, with the available nitrogen supply and even with the form in which the latter is added.

Mr. Martin Jones dealt with the competition to which the constituents of grassland are subjected by neighbouring plants and showed how differences in habit or rate of growth lead to the dominance of certain forms or the suppression of others. Grazing by animals is of the greatest importance in this connexion, the effects on the development of any particular constituent varying according to the intensity of grazing at any given period. The correct management of grazing is therefore essential for the maintenance of any particular type of pasture.

TROPICAL FORESTS

In a session devoted to "Succession of Tropical Forest Types" Dr. Burtt Davy dealt with the evolution of tropical African forest types and pointed to the presence of a considerable percentage of Indo-Malayan forms in West Africa though they are no longer to be found in East Africa. He attributed this peculiar distribution to elevation of the land surface, subsequent to migration, with resulting lowering of temperature and desiccation of considerable areas of low country. It was therefore suggested that low-level, broad-leaf tropical rain-forest was at one time more widespread in East Africa than it is now. The presence of a small but significant palæoarctic element extending from Abyssinia as far south as temperate South Africa indicates relatively modern immigration along the temperate zone corridor formed by the high eastern mountain chain.

The distribution of forest types in Nyasaland was briefly described by Mr. P. Topham. The range of elevation within the region extends from 200 ft. to 10,000 ft. and at least nine groups of forest types are to be noted. The biotic factors of greatest importance in relation to distribution are local history, bush fires, cultural methods, fallow periods, grazing and soil rejuvenation by termites. In the absence of long-term fire protection experiments and of fuller local records, the ecological succession of the different types is largely speculative.

The distribution of various Nigerian forest types in relation to temperature, rainfall and elevation was described by Mr. W. D. MacGregor, and particular stress was laid on the succession from the open parkland

to the moist deciduous type of forest. Experiments have shown that over considerable areas such a succession takes place with fair rapidity provided there is a nucleus of deciduous forest sufficiently near to supply an abundance of wind-borne seed and provided the area is protected from farming and, in its earlier phases, from grass fires. The importance of enlarging the area of deciduous forest as a check to advancing desiccation from the Sahara was emphasised.

Mr. P. Richards gave a comparative account of three areas of tropical rain-forest situated in British Guiana, Sarawak and Nigeria respectively. Each area was studied intensively rather than extensively, and the data were collected so far as possible in a quantitative form. The structure was studied by means of profile diagrams based on measurements of all the trees on clear-felled plots, and the floristic composition was at the same time determined. The structure is fairly similar in all three localities. An interesting point is the close analogy of the forests on white sand in Sarawak and British Guiana, suggesting that there may be parallel edaphic variations from the climax in different regions of the tropics.

An ecological investigation of peculiar interest was described by Mr. C. G. Trapnell in relation to the application of ecological methods to the study of native agriculture in Northern Rhodesia. Various native tribes have discovered—some more exactly than others—the association of certain wild plants with soils of a certain type and are able to fix on the location and decide on the nature of their cultivated crops in accordance with such observations. Efforts to advance the prosperity of the country should be directed towards building on the foundations already laid by the native himself, rather than to hazardous introductions or innovations.

FRUIT STORAGE

The enormous amount of research, much of it emanating from Empire sources, which has in recent years been directed to problems of fruit storage and transport, made it peculiarly suitable that a session of the Conference should be devoted to that subject. The fact that, as one speaker pointed out, imports of Empire fruit into the British market have increased six-fold in the last twenty-five years and now constitute nearly half of the total import shows how research and the practical application of it are proceeding hand in hand with the advancement of Imperial trade.

Of the eight papers presented, five came from overseas contributors and the remainder from workers of the Food Investigation Board. The problems involved are of extraordinary complexity, involving as they do not merely the factors which immediately affect storage of fruit—for example, temperature and humidity of the store, mode of packing, state of maturity of fruit when put in the store, etc.—but a multitude of others which come into play while the fruit is still on the tree. Such are the effects of soil, of climate, of root-stock and so forth on the keeping quality of the fruit. The problems are in the main similar whatever the fruit or the country of

origin, though the relative importance of the different factors may vary from one problem to another. For these reasons no summary which would even indicate details will be attempted here.

Dr. C. Wardlaw and Mr. R. Leonard discussed the problems of the storage of tropical fruit. Investigations at the Imperial College of Tropical Agriculture range from empirical testing of the storage behaviour of various tropical fruits—banana, lime, grape fruit, avocado pear, etc.—to fundamental studies of the gaseous exchange occurring during growth and ripening. Canadian researches, summarised by Dr. H. T. Güssow, covered the whole field of the storage of apples. Mr. H. Turner of the New Zealand Fruit Board dealt chiefly with systems of refrigeration and methods of stacking fruit in the holds of ships. Mr. N. E. Holmes in connexion with the transport of Australian citrus fruit, discussed fungal spoilage and loss of flavour in relation to age of the fruit, and the value of various methods as tests of the state of maturity, while Mr. D. J. Dreyer described experiments relating to mechanical damage to South African pears. With reference to the gas storage method, which has been rapidly taken up by some English growers of apples in the last few years, Dr. C. West advised a certain amount of caution, as much research work still remains to be done before the method is placed on a sound basis. Finally, papers of a fundamental nature were read by Dr. A. S. Horne and by Mr. R. Gane, the former discussing the results of a quantitative study of the resistance of apples to fungal invasion and the latter dealing with some interesting effects of ethylene gas on the respiration and maturing of banana fruit.

In the final session, Prof. E. E. Cheesman directed attention to the pressing need for greater facilities within the Empire for the collection and classification of crop varieties and related species. The menace of Panama disease and of witch-broom disease to banana and cacao cultivation respectively makes it imperative that wholehearted attempts should be made to discover or to breed suitable varieties of the crop plants resistant to these diseases. The work is seriously handicapped at the moment by the lack of adequate facilities.

An interesting feature of the Conference was a series of exhibits comprising, in addition to the illustrations of South African plants already mentioned, a collection of types of cultivated *Sorghum* and of cowpea (*Vigna* sp.) prepared by the staff of the Royal Botanic Gardens, Kew, and an exhibit illustrating Linnæus's development as a botanist arranged by the Librarian of the Linnean Society.

MULCHING WITH GRASS AND PLANTAIN TRASH AND ITS EFFECT ON CROP AND SOIL CONDITIONS*

INTRODUCTION

IN 1925, after a decade of clean weeding in permanent crops in Uganda, it became evident that the practice had very grave disadvantages under Uganda conditions. All too frequently, erosion was severe and the soil was "dead," having lost all its organic matter. Coffee yields were on the average very low, and areas which did set a big crop invariably suffered from dieback, associated with *Hemileia*, and failed to ripen all the crop. As a result, the Department called attention to the dangers of clean weeding on account of the erosion which was taking place, and an artificial mulch was advocated.

THE SOIL MULCH

The basic idea behind the practice of mulching was one of conservation of moisture, the original and most widely advocated mulch being what was known as a dust mulch. This is a misnomer because all that is intended is that the soil shall be cultivated after each rain to break the capillaries and prevent undue evaporation from the surface. Experiments were made to prove this, and the soil mulch became a standard practice under dry-farming conditions. In fact, the aim of the clean weeding programme in plantation practice was the production of a soil mulch which, by reducing weed competition and direct evaporation undoubtedly does conserve moisture, but Keen, Shaw and others have shown that there can be no capillary rise of water to take the place of that used by the crop unless the water table is within six feet of the surface.

Continual cultivation is needed to keep a soil mulch intact, with the result that the soil of the mulched layer is never used by the roots. The top six inches of soil is normally the most fertile, and under mulching conditions is not available. The continual cultivation also means loss of humus, particularly under tropical conditions, and loss of humus invariably means loss of texture and water-holding capacity. Under tropical conditions, too, the maintenance of a light loose top layer of soil is very expensive, and serious erosion must follow.

ARTIFICIAL MULCHES

Artificial mulches are formed by the application of straw, chaff, peat, leaves, sawdust, stones, or other material on the surface of the land. Most

* By W. S. Martin, M.Sc., Ph.D., A.R.C.S., D.I.C., A.I.C., Agricultural Chemist, Uganda, in *The East African Agricultural Journal of Kenya, Tanganyika, Uganda and Zanzibar*, Vol. I., No. 2, September, 1935.

authorities on soils dismiss this method, because of the expense attached and labour involved, but admit that such mulches are very effective. In calculating the costs they seem to have omitted the tremendous and continuous expense attached to the upkeep of a soil mulch, which should be deducted from the gross cost of an artificial mulch. Very little scientific work on artificial mulches has been carried out, but the following records are interesting.

An experiment at Cornell University to estimate *The Cause of Injury to Maize by Weeds* by Craig in 1908 included a straw mulch treatment, and the results were:

TABLE I

Treatment	Yields calculated to basis of 100 on controls	Soil moisture per cent. during August
		Per cent.
Control ...	100 ...	21·1
Weeds removed but not cultivated	96 ...	18·2
Mulched with straw ...	121 ...	25·0
Control ...	100 ...	18·2
No cultivation weeds allowed to grow	31 ...	9·8
One cultivation weed allowed to grow	98 ...	17·7
Control ...	100 ...	17·7

Here the mulched plot gave an increase of 21 per cent. in yield, and an increase of more than 5 per cent. moisture on the mean control. Unfortunately, there were only single plots of the treatments, and the work was not followed up. Albrecht, publishing in 1922 and 1925, working solely on the nitrate and moisture effects of straw mulching, reported a decrease in nitrates and an increase in moisture under a straw mulch. He also noted that the soil under a mulch became plastic, sticky, and of poor tilth, and suggested that the lower nitrate formation was due to lack of aeration, low temperature and too much moisture.

Beaumont and others published in 1927 and 1933 an experiment on straw mulching in orchards, in which the first samplings after the mulch application showed a decrease in nitrate, but after three years of continuous mulching the nitrates increased over the control. This was explained on the C/N ratio of the lower layers of mulch. No mention is made of yields or of any change in soil texture in this case.

In 1914, in Hawaii, on a sugar plantation, a light tarred or asphalted paper was spread directly over the rows of seed cane and harvested stubble as a measure of weed control. In the middle of the rows, between the sheets of paper, cane trash was used as a mulch. No yield records are available, but the advantages of the practice were so obvious that it was extended to pineapple production. Here records were kept of moisture, temperature, and nitrate content of the soil, all of which showed an increase as a result of mulching.

The value of a mulch as an anti-erosion measure is self-evident from a purely mechanical standpoint, but experiments by Lowdermilk, of the Forestry Research Station, California, have led to an interesting theory which fits the facts. The suggestion is that the force of the rain on reaching the soil is sufficient to detach the clay particles, so that the liquid percolating is muddy and tends to clog the soil pores. To prove this he percolated ordinary soil first with clear water and then with muddy water. The result was a 90 per cent. diminution in percolation within six hours of using the muddy water, and the drainage water was still clear. On reverting to clear water percolation rate did not improve. Anyone who has seen puddles during rain on cleared land must have noticed that the water is muddy and the fact that muddy water reduces percolation and enhances the possibility of run-off is proved. Any sort of artificial mulch will protect the surface soil from the force of the rain and reduce the chances of a muddy percolating liquid.

TRIALS IN UGANDA.

PERMANENT CROPS.

The main objection to mulching on European estates is the cost. This varies with the density of the grass cut and the distance it has to be carried. Plantation costs have varied between Sh. 10 and Sh. 60 per acre. In a few instances, where lorries were used, the costs were over Sh. 100 per acre. To attempt to put the question on an economic basis an elaborate 8 × 8 Latin square experiment was laid down on Mr. Stafford's estate at Hoima. The treatments were:

TABLE II

The Effect of Mulching as Compared with various Fertilizers

Treatment	Yields of Cherry in Cwt. per acre									
	A	B	C	D	E	F	G	H	Mean	Significant difference
Yield	3·61	6·1	3·27	7·0	5·92	6·08	6·65	18·1	7·09	4·14
Percentage of mean	51·0	86·1	46·1	98·8	83·5	85·8	93·8	255·3	100	58·5

		Per acre
A.	Sulphate of potash	2 cwt.
B.	Superphosphate	2 cwt.
C.	Control	—
D.	Diammonphos	180 lb.
	Sulphate of potash	2 cwt.
E.	Superphosphate	2 cwt.
	Sulphate of potash	2 cwt.
F.	Diammonphos	180 lb.
G.	Cotton seed	3 tons
H.	Elephant grass mulch	12 ins. deep

Here the mulch gave more than double the yield of either cotton seed or Treatment D—a complete, easily soluble, artificial manure, so that the mulch can bear at least twice the cost of application of any other fertilizer. The actual difference between the mean mulch yield and the mean control is 2.3 cwt. of clean coffee, which at Sh. 40 per cwt. on the estate amounts to Sh. 92, and on this estate the mulch cost was Sh. 63 per acre—a net gain of Sh. 29 per acre, without deducting weeding costs from that of the mulch.

An experiment was laid down at the Government station at Bugusege in 1928 on a 5 × 5 Latin square with the following treatments:

A.—Clean weeding.

B.—Green manure (two crops a year).

C.—Banana leaf mulch.

D.—Weed cover.

E.—October to March cover.

The results to date show the treatments A and C are significantly better than the others, whilst treatment E is better than B and D. The picking season of C is longer than that of the other treatments, but 80 per cent., of its crop was picked within a period of one month.

TABLE III

Effect of Ground Treatment on the Yield of Coffee

	Yields in lb. of Cherry					
	1930	1931	1932	1933	1934	Total
A	190	408	3,731	2,789	1,512	8,630
B	184	315	3,713	1,702	1,202	7,116
C	168	390	4,211	1,988	1,760	8,517
D	205	255	2,844	1,909	558	5,771
E	192	405	4,465	2,290	493	7,845

There are indications that mulching is giving a more even annual crop, as opposed to the big fluctuations normally met in Uganda.

A combined field and laboratory experiment is being carried out to test the effects of various ground treatments on soil moisture, temperature, and nitrate content. The treatments are: (a) Clean weeded; (b) Cover crop (*Centrosema pubescens*); (c) Weeds slashed; (d) Mulch. The experiment has been running for nearly two years, and it is definite that the soil moisture under a mulch is much higher than the other treatments, and the temperature lower. For the first year of its growth the cover crop was the driest, but afterwards it recovered, and at the time of writing it is almost as moist as the soil under mulch. Nitrates under mulch and cover crop are both lower than in the clean weeded plot. There are also indications that some soil types under mulch tend to become sticky and plastic, as recorded by Albrecht. Up to the present there is no acidity change, and

the most probable explanation is that under a mulch a soil is not exposed to alternate wet and dry periods, which help to preserve the texture of heavy soils in the tropics.

To combat this tendency, and to reduce mulching costs, alternate row and alternate year mulching was tried at Hoima.

TABLE IV

Comparison of Complete and Alternate Row Mulch

Treatment	Mean Yields of Cherry in cwt. per acre		
	1933	1934	Mean 1933 and 1934
Complete mulch (long grass)	9·2	12·0	15·1
Alternate row mulch (chaffed grass)	4·8	11·7	8·24
Control	4·0	11·2	7·57
Complete mulch (chaffed grass)	5·4	15·7	10·53
Alternate row mulch (long grass)	6·0	18·5	12·25
Significant difference	2·7	6·7	3·79

From these figures it is evident that there is no necessity to go to the expense of chaffing grass, and the complete mulch is not significantly better than alternate row mulch, which can be applied at half the expense and will help the soil to regain texture.

To test the effect of mulch together with other treatments on young coffee an experiment was laid down at Lukumbi, with the following results:

TABLE V

Ground Treatment and Manuring on Young Coffee

Treatment	Mean yields of Cherry in cwt. per acre		
	1933	1934	Mean 1933 and 1934
Cotton seed (3 tons per acre)	17·00	50·43	33·71
Control	11·97	39·30	25·63
Meraco bonemeal (10 cwt. per acre)	17·12	43·71	30·42
Green manure	13·02	38·45	25·74
Mulch	15·60	51·11	33·35
Niciphos (240 lb. per acre)	15·63	48·10	31·86
Significant difference	4·18	7·83	2·11

In this case there was no significant difference in yield between mulch and the two manuring treatments, but the difference in the appearance of the trees was remarkable, in that the trees of the mulched plots carried their crop well and the other plots all showed the typical signs of overbearing.

PRACTICAL APPLICATION IN UGANDA

It is evident, both from the results of the experiments already given and from actual observation in the field, that as far as Uganda is concerned, mulching is the best treatment for coffee yet discovered. This is particularly true in native agriculture, as with scattered native plots the cost of the mulch is practically nil. The native Arabica coffee-growing industry in Bugishu was in a very poor state in 1930, but after mulching was adopted the industry reached a sound position.

In Buganda, where the main native coffee crop is Robusta, mulching is also being encouraged, and in the drier areas the policy has been to establish coffee only where grass is available for mulching.

On plantations, the difficulties of mulching are twofold—the availability of mulching material and the cost of application. Both difficulties are solved to a certain extent by alternate row mulch, which enables a bigger area to be treated with the material available and at the same time halves the cost. By adopting this policy and by reducing the depth of the mulch one planter has been able to cover over three hundred acres, at a cost of little more than Sh. 10 per acre. Areas in which coffee production would have ceased to be economical through loss of vitality in the trees and soil erosion now produce a paying crop. Many aspects of mulching still require further investigation, such as the optimum time of mulching and the effect of mulch on soil texture. The solution of these problems is a local one, depending entirely on climatic conditions and soil type.

CIVILIZATION AND SOIL EROSION.*

CIVILIZATIONS have risen and fallen since the dawn of history. The Chinese alone are unique in that they date their beginnings in legendary antiquity and have continued as a civilization in an unbroken line to the present day. Not until recent years, beginning with George Marsh, has an inquiry been seriously made as to the part that mismanagement of soil has played in the decline or the destruction of civilization, and the inter-relation between civilization and erosion.

Present-day archaeologists, in their post-mortems on excavations of ruins of ancient civilization, have revealed some very illuminating information. They now tell us that some former civilizations, once revelling in a Golden Age of prosperity and surrounded by magnificence and opulence, are crumbled in ruins, half buried in the dust and debris of their own destructive exploitation of the lands they once cultivated. Expeditions of the writer into north-west China revealed that it was the destructive handwork of man more than climatic changes which reduced those once prosperous and rich regions to a land of poverty and decadence.

Aerial photographs of ruins in Asia Minor, Palestine, North Africa, and Peru are strikingly similar. All such ruins are in the regions of scarce vegetation, bare hillsides, and rock lowlands. History tells of vast armies surging back and forth across these regions. They must have been entirely dependent for food upon the surrounding country. Yet, now those barren, dry lands scarcely sustain the scattered native populations.

The great despoiler of civilizations and landscapes is soil erosion, by wind and water. It is a disease which has followed mankind throughout the centuries in his exploitation and destructive treatment of the good earth from which he received his sustenance—a disease, difficult to discern at first and responsive to treatment in the early stages, but absolutely fatal to civilization in its final stages.

As the civilizations increased in population the crop demands upon the surrounding lands became greater. In the arid regions, enlarged herds overgrazed their hill lands, destroying the vegetative cover and grinding with their hoofs the ground to powder. The exposed soils in dry seasons were swept aloft and blown by the wind and in rainy seasons were washed down the slopes by torrential flows to ruin the fertility of the lowlands. Cooke believes that the Maya civilization had to migrate because it was choked to death by mud washed from its own hillside corn patches. Palestine and north China cut off their forests as the increased

* By W. C. Lowdermilk, Soil Conservation Service, United States Department of Agriculture. Extracted from the *Journal of Forestry*, June, 1935.

demand for food required the cultivation of the slopes. According to the steepness of the slopes, the rich humus soil which had been centuries in the making washed off in from three to twenty years, leaving the land sterile, rocky and bare, unprotected, and each rain dumped debris on the fertile lowlands or choked the irrigation canals and rivers with silt.

This acclerated erosion as an enemy of civilization is not the geologic erosion which slowly cut through rock formations, rounded off the hills and filled in the valleys, and carved, like slow moving glaciers, the grandeur of canyons and gorges. But this geologic erosion does act as a measuring stick to show the rapidity of acclerated or man-induced erosion.

No nation in the history of the world has gone at the destructive exploitation of its natural resources with the rapidity and thoroughness that that we have here in the United States.

Coming events cast their shadows before them. Therefore, if we as a civilization are to be saved from the fate of some of these former decadent and fallen civilizations, it is imperative that we launch a co-ordinated land-planning programme for the conservation of our forests, agricultural and range lands, and our water resources.

The Physical Crisis of Land Use.—The present physical crisis in land use within the United States is a consquence of the period of exploitation in the rapid occupation of the North American continent by the American people. The time when worn out land can be abandoned for virgin soils lying to the west, with their stored fertility, is gone. Practically all the lands of the country best suited to agriculture have now been occupied. The old agricultural frontier has dissolved into the Pacific; the new frontier has reappeared under foot on the farms now under cultivation. In like manner, the forest frontier is being destroyed. The fundamental problems of land use now reside in the conservation of soil, forest, and water resources and in intelligent soil and forest, range, and farm management.

A brief review of the course of occupation of the American continent aids in clarifying certain problems of present land use and in forecasting some of the exigencies of a future soil-conservation and land-use programme so vitally essential to sustained use of our land and forest resources.

Except in an insignificant way, the aborigines of North America had done little to cultivate the soil or to change the virgin character of the land surface and its vegetation. The coverage of vegetation and the soil protected by it were natural responses to long processes of soil and plant development under favourable climates. The streams bore oceanward the residue of precipitation waters that flowed gently from sloping areas and nourished vast unbroken stands of vegetation. Rivers draining the regions covered with dense vegetation generally ran clear except in high flood, when channel erosion furnishd the major burden of silt. This channel erosion generated soil creep from vegetated slopes and in addition to the processes of solution, served to sculpture and wear down the land with

the leisure of geologic processes. Moreover, where comparatively rapid differential land uplift through deep-seated geological processes had occurred or, within climatic zones too rigorous or too arid to support an unbroken cover of vegetation, storm waters carried substantial quantities of silt and erosioned debris into drainage streams. Processes affecting the land proceeded in these instances at more rapid rates; streams ran muddy throughout most of the year, as in the instances of the Missouri and Colorado.

In the broad expanses of the country, from semi-tropical to boreal climates, from humid to arid conditions, there spread before the eager colonists an infinite variety of conditions. By far the larger area was completely covered with vegetation, ranging from grasses to dense forests. Such coverage had, in the long period of interdependence of soil formation and vegetative succession, protected the land surface from rain and melting snow by deep soils, honeycombed by the burrowing of insects and plant roots and otherwise made porous by natural processes of soil development. Little surface washing occurred. Certainly the processes of erosion, which may be designated under these circumstances as geologic norms of erosion or normal erosion, had not proceeded at rates in excess of soil formation from the materials of the substratum; for beneath the mantle of vegetation lay the nourishing soils of varying depths, the products of intricate process of soil formation over incalculable periods of time. This fact is of highest importance in considering problems affecting long-time planning in land use. Soil erosion had not exceeded soil formation from beneath under the natural conditions obtaining prior to the "agricultural conquest" of the forested and grass-covered lands of the nation.

Into this pristine continent entered the colonists with a burst of energy that began a transformation of the land at a rate probably never before occurring in the history of any nation, and with it the creation of fabulous wealth. There were reservoirs of populations in Europe which supplied, in a comparatively short time, millions of vigorous people to clear away the forests and to cultivate the soil as the agricultural and forest frontier was rapidly pushed westward. It was no steady infiltration into undeveloped regions, but a rapid advance over a wide front by farmers, lumbermen, and stockmen with their ploughs, axes and herds. Frontiers were pushed farther and farther westward at a pace that eliminated planning or even thought of the effect of man's activities upon the abundant natural resources that everywhere swept away to the horizon. Man was busy clearing the land of forests, "subduing the wilderness", slaughtering the buffalo for their hides, and breaking out first the sod of the prairies and then the short grass of the plains of the west. In his eargerness, the settler lost sight of any need for conservation and failed to sense his stewardship of the new-found continent.

Withal, it is only necessary here to call attention to the significant change in rate of erosional processes occasioned by the clearing and burning of forests and other vegetation, the breaking of the soil with ploughs, and the heavy consumption of the forage herbage by rapidly multiplying herds.

Soils which had been thoroughly protected through thousands of years of time by unbroken mantles of vegetation, and, for this reason, had weathered to fine textures with high organic contents so favourable to "mellowness" and good fertility, were suddenly exposed to the dash of torrential rains characterising the climate of extensive regions. There began under these conditions a rate of soil erosion greatly in excess of the rates that hitherto obtained. The significant fact of this period of indifferent land use, still continuing over an expanding area, is that the rates of soil removed by rainwash greatly exceeded, and still do exceed, the rates of soil formation over vast areas—a sure process of land destruction. Topsoils have been literally washed away, leaving raw, comparatively unproductive, unabsorptive, intractible subsoil exposed at the surface, broad instances of which condition are conspicuous throughout the major agricultural soil provinces of the nation—as the Piedmont Plateau, the areas of rolling glacial and loessial soils, much of the Atlantic and Gulf Upper Coastal plains province, the Great Plains region, and the greater part of the crop and grazing areas of the west. Moreover, concentration of runoff has removed the topsoil and cut enormous gullies deep into the underlying subsoil materials, from which true production topsoil is formed only through ages of natural processing. These gullies are cutting headward and laterally into valuable farms and forests, discharging with maximum speed the concentrated rainfall descending from the upper watersheds into drainageways and upon valley lands. So malignant and ruthless has been the work of acclerated erosions that the productivity of millions of acres of rich, virgin farm land in densely populated regions of the United States has been destroyed within less than a century.

THE HEALTH VALUE OF ORANGES.*

IN the present article I shall confine myself mainly to one vitamin, viz., vitamin C, but before doing this, it will be necessray to mention the other vitamins as well and give a general description of these substances, since their value is being increasingly emphasized.

Vitamin A, B_1 and B_2, C, D and E are substances which differ radically from one another, and have been designated by alphabetical letters according to the order in which they became known as such independent entities. It might be explained here that vitamin B was subsequently shown to consist of several different vitamins, which have accordingly been designated B_1 and B_2. Certain scientists, indeed, held that there are seven vitamins B.

MEANING AND INCIDENCE OF VITAMINS

The necessary constituents for the body are proteins (*e.g.*, meat), carbohydrates (*e.g.*, bread and potatoes), fat, mineral salts and the vitamins mentioned above. Funk called these substances vitamins because he thought that they contained the properties of the amines, a particular group of chemical substances. "Vita" is the Latin term for life, and because vitamins are so essential to life, he evolved the name "vitamin" by combining the two words. It has subsequently been conclusively proved, however, that the vitamins are not amines, but the name has nevertheless been retained.

Vitamins are divided into two groups, viz., those soluble in fat (A, D and E) and those soluble in water (B_1, B_2 and C).

Vitamin A occurs in natural fats and oils, *e.g.*, butter, milk, egg yolk and raw carrots. This vitamin is most essential to the growth of the body, which would be impossible without it. If the deficiency is such that growth is completely arrested, the eyes become affected. There may even be a vitamin A shortage, however, without any symptoms being manifested.

A deficiency in vitamin B_1 and B_2 is followed by a disease known as beri-beri. The disease is a neuritis, a degeneration of the nerves. Yeast and vegetable concentrates such as "Marmite" constitute the principal source of this vitamin.

A vitamin D shortage causes rickets, if calcium and phosphorus occur in abnormal quantities or proportions. Vitamin D assists the body in using the two substances to advantage in building up the skeleton, even if the calcium and phosphorus are insufficient or in the wrong proportion. People who spend a good deal of time in the sun need fear no shortage of vitamin D, for sunshine enables the skin to form an adequate amount of the vitamin. The principal source of this vitamin is cod liver oil, which may be strongly recommended for children and babies. To a certain degree egg yolk is also a good source.

---

* By P. J. Hamersma, Division of Chemical Services, Pretoria, in *Farming in South Africa*, Vol. X., No. 112, July, 1935.

Our knowledge regarding vitamin E is still most uncertain. It has not yet been determined whether it is essential for humus, but rats, the animals generally used for experimental purposes, have been found unable to breed without receiving this substance in their food; hence the name anti-sterility vitamin.

VITAMIN C

Viamin C is the one on which we would focus attention. As far as can be ascertained, information regarding the necessity of this vitamin for humans dates back as far as the year 1639. When navigation was still in an unadvanced stage of development and it was therefore impossible to undertake long voyages in a short time, sailors had already realized that it was necessary to provide fresh vegetables or fruit for the trip in order to prevent the development of the dreaded disease known as scurvy. The principal characteristic of the disease is the appearance of numerous slight haemorrhages over the entire body, and more particularly between the teeth and round the bones and specially the joints. The complexion becomes sallow, the skin is easily injured, the gums become spongy and bleed easily and the teeth become loose and brittle. This is followed by almost complete loss of control of muscles and limbs.

It has long been known that citrus fruits constitute the best remedy for the disease. The difficulty with this vitamin, however, is that it is so unstable, readily breaking up into valueless substances, but the medium in which the substances occurs in citrus fruits is such as to ensure its satisfactory preservation. The tastier the fruit, the higher, usually, is the vitamin content. In respect of this excellent property, oranges are superior to lemons, naartjies, limes, shaddocks and pampelmouses and other citrus fruits. After the Great War, research workers were stimulated afresh into determining the properties of vitamin C and isolating it in a pure form. A few years ago Szent-Györgi succeeded in doing this, and to-day, it is a simple matter to make a quantitative determination of the vitamin in its sources.

The Department of Agriculture and Forestry has made use of this knowledge, and experiments are at present in progress to test the effect on oranges of various factors such as storage, temperature, etc. The results thus far obtained bear fresh testimony to the value and high quality of our oranges. It is clear that there is no need for oranges from certain parts of South Africa to occupy an inferior position to those from the Argentine and other countries.

The results of this research work should therefore be used for advertising purposes oversea, in order to convince the consumers there that our oranges, even after being in cold storage for a few months, are by no means inferior, and that the orange they obtain there is virtually the same as when it is picked from the tree in South Africa. Such advertising will naturally improve our market oversea, but in the writer's opinion our orange farmers should first advertise in South Africa and find a local market. We would draw attention to the fact that in many parts of the Union oranges constitute an essential part of the diet.

Although it may seem strange, many people do not eat enough food containing this vitamin. In support of this contention, we would refer to the work done by Drs. Levy and Fox, two biochemists of the Institute of Medical Research, Johannesburg. They have come to the conclusion that although, with the exception of cases occurring directly after periods of heavy drought, scurvy is uncommon in South Africa, the food on which many people live during the winter and early spring reaches very low limits in respect of vitamin C, even though a latent form of scurvy does not break out.

Popular opinion has it that the disease is unknown in South Africa; this is not altogether true. A person receiving into his system an insufficient amount of the substance known to scientists as ascorbic acid may be suffering from the disease in a partial form long before any suspicion of it arises. Many common ailments would not exist if correct and adequate nutriment were ensured; and vitamins play an important part in nutrition. Inadequate nutriment in this direction may lead to a state of chronic ill-health, loss of weight and anaemia. These conditions are generally attributed to other causes, and before they are noticed the teeth of the affected person may already have been affected by a shortage of vitamin C.

In September, 1934, an article appeared in the well-known scientific periodical *Chemical Age*, in which it was held that vitamin C appears to constitute a cure for quite a number of diseases against which medicines are of no avail, such as, for example, Werlhoff's disease, certain forms of haemorragica, nephritis, haemophilia, pyorrhoea and others. The irony of it all is that these diseases are never associated with vitamin shortage. The writer maintains, further, that humanity as a whole would appear to suffer from this shortage to a far greater extent than is ever suspected.

It is often said that oranges ripen at the wrong time, viz., in the winter. Actually, however, it is so arranged that during the winter we have at our disposal a very necessary factor. Oranges are juicy, and these juices serve to preserve the vitamin, which, as alreay mentioned, is an unstable substance, easily undergoing change. We ought to appreciate this fact and not wish to eat oranges in the summer only.

Since we find even orange farmers who do not eat this beneficial fruit, it is difficult to understand how they expect to do so. Apart from being eaten raw, oranges may be converted into a great number of delicacies. In cooking preserves, attention should be paid to the importance of cooking rapidly, rather than more slowly at a lower temperature. In addition, the container should be kept closed as far as possible during heating and cooling.

It should be noted, further, that sweet citrus fruits contain fructose as well as valuable salts, which are essential to good health.

People who are frequently troubled with heartburn are usually under the impression that such fruits will aggravate the position, but this is not so, as the juices after digestion have an alkaline reaction. Very few people are adversely affected by such natural foods.

In conclusion, we would point out that although the present article deals principally with the orange, what has been said about it is also applicable, in a lesser degree, to the other citrus fruits. It is impossible to overstate the value of these fruits, and the sooner we export less of our oranges and sell more locally, the better will it be for the public health.

MEETINGS, CONFERENCES, ETC.

MINUTES OF THE FIFTH MEETING OF THE CENTRAL BOARD OF AGRICULTURE

THE fifth meeting of the Central Board of Agriculture was held in the Board Room of the Department of Agriculture, Peradeniya, at 2.30 p.m. on Thursday, 19th September, 1935.

Dr. J. C. Hutson (Acting Director of Agriculture) presided and the following members were present: Messrs. Wace de Niese, L. W. A. de Soysa, S. Pararajasingham, C. E. A. Dias, N. Bentley Buckle, R. Neville Rolfe, K. Balasingham, A. Canagasingham, Mudaliyar S. Muttutamby, Mudaliyar N. Wickramaratne, Rev. Father L. W. Wickramasinghe, Messrs. P. B. Bulankulama, Graham Panditteseker, C. Arulambalam, S. M. K. Madukande Dissawe, S. Armstrong, U. B. Unamboowe, Wilmot A. Perera, D. C. Gordon Duff, S. Kandiah (Acting Agricultural Chemist), Dr. J. C. Haigh (Economic Botanist), Mr. Malcolm Park (Mycologist), Mr. M. Crawford (Government Veterinary Surgeon), Mr. J. S. Kennedy (Director of Irrigation), Mr. L. L. Hunter (Government Agent, N. C. P.), Mr. C. L. Wickramasinghe (Commissioner of Lands), Mr. James Forbes (Jnr.), (Chairman, Tea Research Institute), Mr. R. P. Gaddum (Chairman, Planters' Association of Ceylon and representing the Chairman, Tea Propaganda Board), Dr. Reginald Child (Director, Coconut Research Scheme), Mr. T. E. H. O'Brien (Director, Rubber Research Scheme) and Mr. L. Lord (Acting Secretary).

Visitors.—Messrs. W. R. C. Paul, J. P. Blackmore, A. V. Richards, H. A. Peiris and A. F. Cantlay.

Letters and telegrams regretting their inability to attend were received from the following members: Mr. Leslie de Saram, Dr. R. V. Norris (Director, Tea Research Institute), Mr. F. C. Charnaud, Mr. A. C. Attygalle, Mr. D. H. Kotalawela, M.S.C., Mr. H. F. Parfitt, M.S.C., Hon. Mr. F. A. Obeyesekere, M.S.C., Hon. Mr. C. W. W. Kannangara, M.S.C., Mr. P. B. Ranaraja, M.S.C., and Mr. A. J. McKee.

CONFIRMATION OF MINUTES

The minutes of the fourth meeting held on 9th May, 1935, were confirmed.

REPORT OF CHANGES OF MEMBERSHIP OF THE BOARD

The Chairman stated that vacancies had occurred due to the death of Mr. G. Robert de Zoysa and the resignation of Mr. Gordon Pyper. On the proposal of the Chairman the meeting passed a vote of condolence with the relatives of the late Mr. de Zoysa. The following changes were announced:

1. The Planters' Association of Ceylon have nominated Mr. A. J. McKee to act for Mr. C. Huntley Wilkinson during the latter's absence from the Island.

2. The Ratnapura District Agricultural Committee have elected Mr. A. C. Attygalle as their representative in place of Mr. E. E. Megget.

3. The Kalutara District Agricultural Committee have elected Mr. Wilmot A. Perera as their representative in place of Mr. F. H. Griffith.

4. The Kurunegala District Agricultural Committee have elected Mr. M. Prasad, Acting Government Agent, N.W.P., as their representative in place of Mr. C. Harrison-Jones who is on leave out of the Island.

5. Mr. B. M. Selwyn has tendered his resignation from the Executive Committee of the Central Board of Agriculture on his proceeding on leave out of the Island.

The Chairman stated that two vacancies on the Executive Committee of the Board were to be filled and called for nominations. Mr. R. P. Gaddum was proposed by Mr. Jas. Forbes and seconded by Mr. Wace de Niese, and Mr. L. W. A. de Soysa was proposed by Mr. S. Pararajasingham and seconded by Mudaliyar N. Wickramaratne. There were no further nominations and these gentlemen were duly elected.

INCREASING THE PRODUCTION OF PADDY IN CEYLON

Mudaliyar N. Wickramaratne moved :

> "That in order to increase the production of paddy for the national security of the people of this Island and in order to induce the general agricultural communities to take to paddy cultivation, a guaranteed uniform minimum price for paddy should be fixed by Government."

In support of this resolution which had been discussed at the meeting of the Board held in January last and on which action had been deferred, the Mudaliyar pointed out the great importance of paddy cultivation. Owing to the present food shortage in the Island quantities of rice had been imported which exceeded those imported during the famine of 1919-20. He said that subsidies had been given to beef, sugar and wheat in England and that it was equally important to subsidize paddy cultivation in Ceylon. He suggested that paddy should be purchased at a fixed good price, milled at the Government rice mill and the rice sold through the Marketing Commissioner. In seconding the resolution Mr. C. Arulambalam thought that the lowest mimimum price of paddy should be Rs. 3·00 per bushel and drew attention to the high cost of cultivation of rain-fed paddy, large areas of which existed in the Island. He also said that for colonization schemes he was in favour of Government providing hospital accommodation, a proper supply of drinking water and concession rates for colonists on the railway. He was against placing an import duty on paddy and not on rice. Father L. W. Wickramasinghe spoke in support of the resolution and suggested a minimum price of Rs. 2·00 per bushel. After a discussion during which Mr. Wilmot Perera stated he was opposed to anything which would increase the cost of rice to the poor consumer

the motion was carried with one dissentient and the Secretary was instructed to forward a copy to the Hon. the Minister for Agriculture and Lands.

IMPROVEMENT OF PADDY CULTIVATION

The Chairman asked the meeting for permission to take next agenda item 9 as this, like the previous motion, dealt with paddy cultivation. On permission being granted the Chairman called on Mr. S. Armstrong who read the following paper.

"My object this afternoon is to present to you certain suggestions so as to improve the yield of paddy cultivated under irrigation works where water can be had, but the method of cultivation in vogue has not in the least been improved for want of knowledge and experience on the part of minor officers who are directly in charge of.

2. "It is an admitted fact that other countries with immense resources are concentrating their attention on a greater production of food in their own countries to make them self-sufficient in the matter of their essentials. How much more incumbent should it be on us in a country without any such protection to produce our own food supply more so because we have ample opportunities of doing so. Rice can be grown in Ceylon sufficient for our consumption if we set about it in the right direction.

3. "If we let this opportunity slip without solving the question of an assured food supply satisfactorily we may not feel sufficiently interested till another crisis arises when we alone will be blamed for our inaction. It goes without saying that if we adopt improved and intensive methods of cultivation, we can produce a good deal more, even from the area already brought under cultivation. We have not only sufficient land, but sufficient men. If the millions of people who are mainly agriculturists can be properly oganised and trained with an agricultural bias they can produce thrice or four times the quantity of paddy they now produce.

4. "It is said that paddy cultivation was known to Ceylon for over 2,500 years and the knowledge of transplanting, weeding, etc., is equally ancient. It may be safely asserted that where paddy cultivation is manifestly inferior, it is more generally the result of the absence of facilities which exist in the better districts than of internally bad systems of cultivation. The reason for not adopting these methods is not ignorance but want of capital, insufficient rainfall, scarcity of labour, precarious condition of the cultivation and, withal, small profits.

5. "If countries like England, Germany, Japan, the United States and Italy want something more than demonstration to make the cultivators resort to intensive and extensive cultivation it cannot be contended that the Ceylonese villagers are not in need of such assistance. We have proof in our own country of the effects which greater profits have on cultivation. Our food crisis of 1918

or 1919 was very little when compared with our crisis in 1920. And yet we find, on reference to the Blue Book for 1918, that 'the higher price of paddy has induced many cultivators to take up lands that have been uncultivated for some time'.

6. "Such assistance the farmer requires may be given in any of the three ways: (1) protective tariff, (2) bounties, and (3) guaranteed prices. Perhaps the easiest will be, as suggested by Mudaliyar N. Wickremaratne of experience, to impose the tariff on imported paddy and rice and not on paddy alone. What is necessary is an immediate announcement that the Government will protect the farmer against loss from low prices. He must feel that the State is behind him.

7. "Almost all progressive countries like the United States, Germany, Austria, France, Japan, Canada, etc., have adopted protection and our economic conditions would seem to make it all the more reason why Ceylon should follow the example.

8. "Paddy in Ceylon is the least profitable form of cultivation. It is not only precarious, but is also, on the whole, a profitless industry. Sir C. P. Layard, with 50 years' experience as a Revenue Officer, acquainted with lands of all qualities and in every part of the Island, is reported to have said that paddy growing is the most unremunerative occupation in the Island and that it yields, on an average but a penny a day on the labour bestowed on it. This opinion is shared by many officers of varied and general experience.

9. "The question has often been asked, why then is paddy cultivated, The more important reasons for people engaging themselves in paddy cultivation, according to Mr. Balasingham, are the following:

   (1) Men do not easily give up their hereditary occupation.

   (2) There is no other kind of agricultural or industrial work in some districts in which the cultivators may be regularly employed.

   (3) Even where there is other work, many people consider it more honourable to do agricultural work in their own fields or as tenants, rather than work as coolies on plantations or in the town. Even when social position is no bar to doing cooly work it is difficult to change settled habits.

   (4) The bulk of paddy lands are not suited to any other kind of cultivation and, consequently, even when there are competing kinds of agriculture such as tea or coconut in the district or village, paddy lands cannot for the most part be cultivated with such products.

   (5) In some districts far away from markets and roads the farmers do not cultivate for profit but for their food. In such cases, even if the paddy lands are suitable for other and more profitable products there is no inducement to cultivate such products.

10. "The pages of the Hansard show how uncertain is our rice supply from India. Particulars of the serious famine of 1866, 1876 and the rice crisis of 1919-20, all convince us that it would be foolish to depend on Burma and India for our rice. It is, therefore, our duty to produce enough for, at least, our own demands.

11. "Another factor which would contribute to an appreciable increase in the production of paddy and the cultivation of every cultivable paddy land during both the seasons in the year and organised cultivation is the alteration of the system of supervision of the work of Minor Irrigation Headmen, with the result that they will be placed directly under Agricultural Officers the benefit of whose advice and assistance is not available at all times to the cultivator, as they have at present no voice in the control of Minor Irrigation Headmen in the cultivation of fields under irrigation works.

12. "If paddy cultivation is to be the success aimed at, we should make irrigation administration more liberal. The distribution of water may be left with advantage in the hands of officers who have practical experience in paddy cultivation. It is unfair to expect Irrigation Officers, who have no knowledge of paddy cultivation, to manage this satisfactorily. There was a time when the Irrigation Department was purely in charge of irrigation works as well as the control and issue of water. In 1917 the conditions were improved by the transfer and the control and issue of water to the Government Agents with Irrigation Sub-Inspectors or Irrigation Inspectors to assist them. This may be characterised as a distinct improvement in the system of management and control over cultivation. My suggestion is that these Irrigation Officers should be replaced by Agricultural Instructors, with the necessary technical knowledge and practical experience, under the Government Agents so that they may bring about the cultivation of all cultivable paddy lands in their respective areas and to supervise and do everything in their power, with the advice of the Divisional Agricultural Officers to organise cultivation in a systematic way. I make bold to say that such a departure from the present arrangement will doubtless lead to intensive and improved methods of cultivation referred to above.

13. "It may be argued that Agricultural Officers are not conversant with the control and issue of water and any alteration would result in complications. It is my personal experience of years that the matter of controlling the issue of water is more within the purview of agricultural engineering than irrigation engineering. It may be pointed out that any work such as construction of field channels, etc., involving a knowledge of irrigation engineering, may be attended to by the staff of the Irrigation Department in the Sub-Divisions within which all major works are situated without any increase to the staff. It may also be contended that an Agricultural Instructor as Cultivation Officer will not succeed in the economic issue of water as he is not conversant with an irrigation

scheme, and that the channel bunds will burst and rivers will overflow and water wasted when issue of water is made indiscriminately. This argument can be easily met when a key plan showing in detail the areas to be irrigated by the respective distributary channels and elas in existence and their capacities to hold water and the acreage that can be cultivated under each foot of water in the tank is supplied to the officer in charge of cultivation. The Agricultural Officers so appointed would be Cultivation Officers as well. Their duties normally would include supervision of the work of Minor Irrigation Headmen, all minor irrigation works, such as cutting of subsidiary field channels of short lengths, erection of sand dams across rivers, etc. They should be empowered to issue such orders to Vel Vidanes as they consider necessary. Prosecutions by the Vel Vidanes to be only with the approval and consent of the Cultivation Officer.

14. "I would point out that the proposal is in accordance with the recommendation of the 'Executive Committee on Re-organisation and Retrenchment on the Departments under the Ministry of Agriculture and Lands'. Irrigation Officers seconded to work under Revenue Officers to be utilised on organizing work to a greater extent than at present and to be relieved of most of the non-organizing duties they now perform. The Agricultural Department had hitherto concentrated its attention mainly on research work. It is true that the Department devotes more time to the improvement of paddy cultivation and the various crops raised by the villagers. Much might be done by the Agricultural Department, in co-operation with the Veterinary Department, to improve the primitive system of animal husbandry that prevails in the Island. The ordinary cattle owner has not yet appreciated the necessity for the systematic feeding and improving of the stock of country bred cattle. The responsibility for the selective breeding of cattle and the growth of fodder grasses would seem to be with the Agricultural and Veterinary Departments.

15. "Moreover, it is essential that the result of research work carried out by the Department should reach the persons who are directly concerned, namely the producers themselves. The importance of propaganda work is the principal means of acquainting the rural cultivator of the result of research. It is obvious that no improvement is possible in rural agriculture unless the Department gets into touch with the villager, 'demonstrate his enemies to him,' and invokes his assistance and interest in their control instead of the perfunctory manner in which casual visits are paid. It is the considered opinion of the Sub-Committee on Re-organization in the Departments under the Ministry of Agriculture and Lands that alongside the work of propaganda, actual demonstrations of the manner in which a cultivator should grow his produce must be given. For this purpose demonstration blocks should be started in all parts of the Island. Apart from the work that Agricultural Instructors do in

Government farms it is extremely necessary that they should volunteer assistance to any peasants who need guidance in their agricultural difficulties. When necessary the actual demonstration itself should be done in the cultivator's own plot. Not only labour-saving methods but also economical ways of cultivation practised in other countries should be demonstrated and methods that have proved useful in one locality should be introduced into other parts. One cannot do better than quote *in extenso* the remarks of the sub-committee referred to above, viz., 'Even after all details of reorganization have been carried out, the Department cannot work at maximum efficiency unless its various members possess a genuine enthusiasm for their occupation. The general criticism that can justly be made against some of the instructional staff of this important Department is that they do not seem to have appreciated the far-reaching character of the work in which they are engaged. Unless they are themselves interested in the work committed to their charge, it is inconceivable how they can rouse the conservative peasant to take pains over methods of improvement. It is, therefore, essential that the Instructor who would act as Cultivation Officer should have more than a perfunctory enthusiasm for the advancement of agriculture. Unlike other duties in Government service mechanical accuracy alone is not a test of efficiency here. This being the case, it is absurd to expect Irrigation Officers seconded for duty under the Revenue Officers to bring about improved cultivation methods and to remove obstacles to agricultural progress.

16. "The control of seasonal cultivation operations and the distribution of water over the lands is a matter directly under the control of the Revenue Officer in his administrative capacity. In this matter the cultivator will have better opportunity of securing from Agricultural Officers advice, demonstration and assistance to the best advantage and not from the Irrigation Officers officiating as superintendents in charge of issue of water only.

17. "If the proposal submitted is given effect to, it may become necessary not only to strengthen the staff already under Revenue Officers in certain cases but also to relieve some of them of the duties which now devolve on them as regards issue of water, convening of meetings, cultivation, control, etc., and leave them entirely in charge of construction work, as recommended by the Executive Committee previously referred to, after hearing the evidence received at the different conferences and in course of their inspections throughout the Island. It was one of the recommendations of the Executive Committee that the past policy in regard to irrigation should be changed and the principal activities of the Irrigation Department be directed to the restoration and improvement of irrigation works throughout the Island.

18. "The Acting Director of Irrigation in his report on the activities, organisation and establishment of the Ceylon Irrigation Department which forms part of Sessional Paper VIII—1932, observes

that 'much time and patient endeavour has been devoted to studying and understanding the real needs of cultivators in the matter of their irrigation demands. Much has already been achieved in standardising on different schemes such data as frequency of water issues, amount of water issued, sowing dates, close seasons, early notification of maximum capacity of available storage and many more matters of first-rate importance to the actual cultivator. The object of the Department in pursuing such research is, of course, to ensure that the maximum possible use is made of the water available and it is impossible to underestimate the value of such knowledge and of its judicious application or even, if necessary, its enforcement.' He concludes his remarks on the aspect of the question with the following: 'The enforcement of such manifestly commonsense rules is the practical and often insurmountable barrier to economical development of many irrigation schemes in this Island and, in its patient endeavours to apply commonsense principles to irrigation practice for the good of cultivation in general, the Department has incurred a wealth of the vituperative odium that is as universal as it is unmerited.'

19. "It cannot be ignored that there are serious difficulties to be overcome and one of them is the antagonism of the cultivators towards any voluntary enterprise beyond the barest minimum imposed by their immediate requirements. It is said that a certain amount of coercion which can certainly be benign, but must represent definite and continuous control is an indispensable factor of any sustained policy of paddy development. Being fully convinced of the essential importance of this fact, the Irrigation Department is said to have always regarded any compromises between control and laxity as the casting of a fundamental principle and a dangerously retrograde step and has, in consequence, been accused of maintaining a harsh, rigid and unsympathetic attitude towards cultivation.

20. "Mr. K. Balasingham, who has served the Legislative and Executive Councils for a number of years and who had made a study of the agricultural and irrigation problems of the Island, has stated that a great saving will be effected if engineers are given purely or at least mainly construction work. We have need for even more Irrigation Engineers if they will spend their time making an irrigation survey of the country and point out where new works may be built with advantage. The remarks of Mr. Elliott, C.C.S., about them are worth noting: 'The chief cause of complaint of the Irrigation Officers is alleged 'wastage of water.' As these gentlemen have had no practical experience of paddy cultivation this term really means a consumption in excess of arbitrary or theoretical limits fixed by the . . . . . Personally from a 5 years' practical experience while opening 500 acres on the Walawe Estate, my sympathies in this matter are with the cultivators, as I suffered from similar views on the

part of the engineer I had to deal with. My complaints of insufficient water were met with the same stock assertions as I see reported in recently published administration reports and ascribed to leaky ridges, crab holes and similar unavoidable and practically irremediable contingencies. Luckily I was in a position to bring my complaints directly under the notice of the then Governor Sir West Ridgeway, and so received a sympathetic degree of redress.'

21. "It is axiomatic that there is ample scope for a large development of paddy cultivation in the Island.' The serious depression which has seriously crippled other agricultural pursuits affords the opportunity and indicates the expediency of fostering food production."

DISCUSSION

Mr. J. S. Kennedy (Director of Irrigation) said that he agreed with Mr. Armstrong's suggestion of freeing irrigation officers from cultivation duties but disagreed with the reasons he gave in support of this. At present irrigation officers were the only ones available for cultivation duties. If, as a result of Mr. Armstrong's motion, we could train a new class of agricultural officer able to act as cultivation officer under the Government Agent, no one would be more pleased than he. He would be glad to arrange for training these officers in the necessary irrigation duties. Mr. Kennedy stated that a large-scale policy of conserving all the rainfall of the dry-zone had been prepared and a start had already been made in putting the policy into effect.

Mr. Armstrong then moved:—"That this Board recommends to the Ministry of Agriculture and Lands that men with agricultural diplomas be selected by the Government Agents of the respective provinces and sent for training under the Director of Irrigation in irrigation and water distribution to enable them to supervise cultivation in place of the present Irrigation Superintendents."

The motion was seconded by Mudaliyar N. Wickremaratne, put to the meeting and carried.

THE COFFEE BERRY BORER

The Chairman, in introducing this item, explained that he wished to inform members of the recent discovery of a serious insect pest of coffee in Ceylon and obtain their advice as to whether any legislative action should be taken in the matter. Specimens of coffee branches and berries, both attacked by shot-hole borer beetles, were received from the Balangoda Coffee Station in June and it was suspected that they might be different species. The branch-borer was quite well-known in the Island, but there had been no previous reported attack on coffee berries by shot-hole borers. Specimens of the latter submitted to a specialist in India proved to be the coffee berry borer (*Stephanoderes hampei*), a wide-spread pest of coffee berries in certain African and Eastern countries. Mounted material and coloured drawings of the various stages of this pest were passed round the meeting.

The Chairman then traced briefly the gradual spread of this beetle from its supposed original home in West Africa to Eastern countries. It was found in Java in 1909 and spread to Sumatra, Borneo and Malaya, where it was discovered in 1929, and to South India where it was reported in 1930. He emphasised the fact that in each country this pest had not been detected until after it had become too well established to be eradicated. How long it had been in Ceylon it was not possible to say, but from the fact that it was well-distributed throughout the Balangoda area and had also been found in Ratnapura, Godakawela and Kuruwita, all in the Sabaragamuwa Province it seemed probable that its introduction was not recent. A circular sent round to all agricultural divisions had indicated that so far the coffee berry borer had not been found elsewhere in the Island.

The habits and life-cycle of this pest were briefly outlined from the results of investigations in Malaya. It was found there that practically all the damage was done by the female beetles which were more active than the males and outnumbered them by about 13 to 1. Two main types of damage were done by the females :—(i) green berries were bored for feeding purposes and later turned black on the bushes and on the ground and served for breeding; (ii) ripe berries on the bushes and on the ground were preferred for egg-laying and breeding; the beans were eventually destroyed by the grubs. The average life-cycle in Malaya was about one month, and preliminary work on this pest at Peradeniya had so far tended to confirm approximately the Malayan observations as regards the bionomics of this pest.

The Chairman went on to report that, in view of the urgency of the situation, a control campaign had been started in the Balangoda District by the Department with the object of reducing the numbers of the pest in the areas already infested and of minimising, as far as possible, the danger of its spread elsewhere. Three Agricultural Instructors had been seconded for this work under an Entomological Assistant from Peradeniya. So far more than 600 coffee gardens had been treated, many of these being in remote villages in the surrounding hills. Usually all coffee plants were pruned and the prunings and crop were burnt; in some cases, however, only the crop was stripped and burnt. All fallen berries were collected and burnt. The campaign was still in progress.

In other countries where this beetle was a pest, sometimes almost an entire crop on any given area was destroyed or seriously damaged. Although coffee was at present a minor village crop in Ceylon, the Department had been encouraging the growth of coffee in villages within recent years, and any pest that was likely to destroy the greater portion of the crop was worthy of special attention.

The Chairman concluded by explaining what kind of legislation would be necessary if the Board considered it advisable to pass a resolution recommending that the coffee berry borer be declared a pest. He appreciated the fact that members had been given no time to consider the matter, but, in view of the urgency of the situation he hoped that they might be able to come to a definite decision at this meeting as to the necessity, or otherwise, for early legislation. He invited comments from members.

In reply to Mr. Wilmot A. Perera, the Chairman said that an unfortunate feature of the outbreak was that the Robusta types of coffee were most heavily attacked and it was estimated that in some gardens up to about 75 per cent. of this crop had been seriously affected. The Arabica types appeared to be comparatively immune, while Liberica types, although but little grown in the Balangoda areas so far inspected, were not severely attacked.

After a brief discussion the Board passed the following resolution proposed by the Chairman: "In view of the serious damage done by the coffee berry borer (*Stephanoderes hampei*) in other countries, this Board recommends that this insect be declared a pest under the Plant Protection Ordinance No. 10 of 1924".

DECLARATION OF THE SPOTTED LOCUST AS A PEST

Mr. U. B. Unamboowe asked if agenda item 8 could be taken next and the meeting agreed to this. Mr. Unamboowe drew attention to the seriousness of the Spotted Locust in parts of the Nuwara Eliya District and particularly at Harangolle. He stated that cardamoms, dadaps, areca palms and garden crops were attacked and said that the villagers were unwilling to carry out control measures owing to religious scruples. He then moved the following motion:

> "That the Spotted Locust be declared a pest under the Plant Protection Ordinance."

Mr. Wace de Niese seconded. The Chairman said that there were certain definite control measures for this pest. These were well-known and were usually carried out effectively on estates by organised campaigns. In village areas, however, no concerted action was ever taken to destroy the locust in any stage and it was usually allowed to attain the winged stage and to continue breeding unchecked. This objection by the villager to taking any action for the control of a pest seemed to be mainly religious. In this particular instance under discussion, officers of the Department had done all they could to persuade the villagers to take action and it was not considered that legal compulsion in this instance would help matters. It was the policy of the Department to try and meet such situations by measures of persuasion and propaganda, rather than by compulsion under the Plant Protection Ordinance.

An article on the Spotted Locust with coloured plate had recently appeared in *The Tropical Agriculturist* and this was to be translated into Sinhalese and Tamil and printed as a leaflet for distribution at lectures organised by the Propaganda Officer in affected village areas.

The Chairman further pointed out that this pest was not known to do any vital damage to any of the main crops of the Island, nor could it be said that village crops were seriously injured; the damage to cardamoms was, perhaps, a new feature of the outbreak in this particular instance.

In the course of the subsequent discussion the Chairman indicated what the declaration of an insect as a pest would involve and considered that in this instance the situation would not be materially affected by declaring the

spotted locust as a pest, unless the co-operation of the villagers concerned could be obtained. In reply to questions it was pointed out that the declaration could be made to refer to any particular area which could be defined and declared an infested area. Mr. Unamboowe said he would be satisfied if the declared infested area was restricted to Harangolle and Tyspane. Mr. Gaddum said that he could corroborate the remarks of Mr. Unamboowe, but, before supporting the motion to declare this insect a pest under the Ordinance, he wished to consult the Agricultural Committee of the Planters' Association. He thought, also, that the views of the Tea Research Institute should be obtained. He stated that the agenda gave no indication that it was proposed to declare the Spotted Locust a pest under the Ordinance and that it was desirable to have a more detailed agenda. Dr. Child pointed out that this item had been on the agenda of the last meeting as "Declaration of the Spotted Locust as a Pest under the Plant Protection Ordinance". Mr. Arulambalam suggested that motions should be printed in full on the agenda paper. The Chairman said it would be inconvenient to include in full all motions on the agenda paper, but that he would undertake to have motions more fully explained in future.

Mr. Gaddum then moved the following amendment:

> "That the question of declaring the Spotted Locust a pest under the Plant Protection Ordinance be deferred until the next meeting."

Mr. Neville Rolfe seconded the amendment, which, on being put to the meeting was lost by nine votes to eleven. On the motion being put to the meeting it was carried by eleven votes to eight.

LEAFLET ON AGRICULTURAL EDUCATION

On being asked to address the meeting on this subject Mr. Unamboowe said that the distribution of leaflets on agricultural matters to villagers was of great utility and mentioned in support of this the benefit derived from Mr. Basset's leaflets on cardamoms and on manure pits. Mr. Armstrong supported the printing and distribution of leaflets and said that the Director of Agriculture should obtain an increased vote for this purpose. The Chairman stated that he would give the matter attention and undertook to issue more leaflets. Mr. Wilmot Perera said that what Mr. Unamboowe meant was the publication in leaflet form of important matters discussed by District Agricultural Committees and Divisional Agricultural Associations. After further discussion Mr. Wace de Niese moved that the matter be deferred until the next meeting. This was agreed to and, the time being then 5.15 p.m., the meeting was adjourned.

L. LORD,
Acting Secretary,
Central Board of Agriculture.

COCONUT RESEARCH SCHEME (CEYLON)

BOARD OF MANAGEMENT

Minutes of the twenty-ninth meeting of the Board of Management, Coconut Research Scheme, held (by the courtesy of the Acting Financial Secretary) in the office of the Financial Secretary, New Secretariat, Colombo, on Friday, September 27, 1935.

Present.—Dr. J. C. Hutson, Acting Director of Agriculture, (in the Chair), Hon'ble Mr. C. H. Collins, C.C.S., Treasury Representative, Mr. J. L. Kotelawala, M.S.C., Hon. Mr. F. A. Obeyesekere, M.S.C., Mr. L. W. A. de Soysa, Mr. Graham Panditteseke re, J.P., U.P.M., Mr. D. D. Karunaratne, J. P., Mr. A. W. Warburton-Gray, J.P., U.P.M., and Dr. R. Child, Chief Technical Officer, who acted as Secretary. Apology for absence was received from Mr. Austin Ekanayake. Mr. J. C. W. Rock, Registrar-General and Director of Commercial Intelligence, was present by invitation of the Board during the first part of the meeting.

TIME OF MEETING

Before the Board proceeded to take up the Agenda Mr. Warburton-Gray moved that future meetings should be fixed for 11 a.m. instead of 11.15 a.m. as this would better suit outstation members. Mr. G. Panditteseke re seconded the motion which was unanimously carried.

MINUTES

The minutes of the twenty-eighth meeting of the Board of Management, held on June 7, 1935, copies of which had been circulated were confirmed and signed by the Chairman.

BOARD OF MANAGEMENT

The Chairman reported that Mr. D. D. Karunaratne had been nominated by His Excellency the Officer Administering the Government to succeed Mr. E. F. Kannangara as Small-holders' Representative on the Board. He welcomed Mr. Karunaratne and thanked Mr. Kannangara for his services while a member; the Chairman also welcomed Mr. L. W. A. de Soysa, who took his seat on the Board for the first time.

COPRA KILN

As Mr. Rock was present the Chairman, with the Board's approval, took agenda items 6 & 9 at this stage. A letter was read from Mr. L. W. A. de Soysa commenting on para 4(b) (ii) of the minutes of the previous meeting suggesting that the Chief Technical Officer should "secure all literature and illustrations on the methods of drying successfully adopted in other coconut producing countries." Dr. Child said that a good deal of literature was available in the office, but it was not practicable to erect such kilns for trial on the Scheme's estate.

Mr. Rock's letter of July 17, 1935, to the Chairman, which had been circulated to the Board, was discussed. Mr. Rock said that his idea was that the Coconut Research Scheme could assist in improving the curing of copra by the villager and possibly also investigate the question of marketing. Mr. Kotelawala and Mr. Obeyesekere both raised the question whether this came within the scope of the Scheme's activities as laid down in Ordinance No. 29 of 1928. It was decided that something of the sort was contemplated by Section 4 (5). "The Board shall, by the provision and publication of information, as well as by advice and demonstration and the inspection of plantations, give practical assistance to persons engaged in the coconut industry." Mr. Warburton-Gray suggested that the appointment of a Small-holdings Officer, as already appointed by the other Research Institutes, would be useful; such an officer could work in co-operation with any other organization for tackling the question of marketing such as was contemplated by Mr. Rock. Mr. Panditteseker agreed. Mr. Kotelawala considered that the duties of an officer and how he was expected to carry them out should be carefully gone into before making such an appointment; it was not easy to see how a Small-holdings Officer would get to work. Speaking on the specific suggestions in Mr. Rock's letter, the Chief Technical Officer said that there seemed to be two ways that the Scheme could investigate the marketing of the Small-holder's produce. In the first place it might be possible, as an experiment, for the Scheme to purchase nuts from villagers in the neighbourhood of Bandirippuwa Estate at the current market price in any quantity, however small. Kiln space was available for curing these nuts and the Scheme could sell the copra. As the villager's crops were usually mortgaged ahead to dealers, there would be no response at first, but he had discussed the matter with local people and thought that later such a scheme might work. If it did, the experiment would provide the proper authorities with some information on which they could base a system of co-operative buying and copra-curing. Mr. Obeyesekere objected that the Scheme itself should not engage in trade in this way. On the second point Dr. Child said that it would be possible for the Scheme to erect on Bandirippuwa, a small kiln suitable for small-holders at the cheapest possible cost for purposes of demonstration and that, as in Malaya, the erection of these by small-holders should be encouraged. Mr. Kotelawala doubted whether this would lead to any useful result; the villager in the coconut districts knew enough about copra kilns to put one up if he wanted to or if he could afford it. Mr Warburton-Gray said that village copra of poor quality was sold at similar prices to good estate copra; the villager therefore had no inducement to improve his quality. Dr. Child doubted whether the villager actually received the value of his produce; although the copra did possibly get the same price eventually, it passed through middlemen's hands first.

The Chairman remarked that it was clear that the Board could not come to a decision on these questions at the present meeting; it was therefore decided that the Chief Technical Officer should put up a report in consultation with Mr. Rock and that the discussion should be resumed at the next meeting. Mr. Rock then withdrew after thanking the Board for their invitation to be present at the meeting.

STAFF

Arrangements at Bandirippuwa.—The Board decided that Mr. W. V. D. Pieris, Geneticist, should hold charge of the Scheme's Research Station at Bandirippuwa Estate as Officiating Chief Technical Officer from October 13, 1935 until Dr. Child's return from leave on or about August 13, 1936.

The Chief Technical Officer reported that Mr. W. V. D. Pieris, Geneticist, resumed duties on June 27, 1935, after his return from study leave.

Appointment of Field Assistant.—The Chief Technical Officer reported that, in accordance with the instructions of the Board at the previous meeting, he had selected Mr. M. Gregory Fonseka for the post of Field Assistant to the Soil Chemist, and that he had commenced duties on July 8, 1935. The Chief Technical Officer's letter No. 35d/828 of June 28, 1935 was read and the Board approved of this letter being regarded as the basis of Mr. Fonseka's terms of appointment.

FINANCE

The Statement of Receipts and Payments for the Second Quarter ended June 30, 1935 was approved by the Board.

The Draft Estimates of Revenue and Expenditure for 1936 as circulated were passed; the Chief Technical Officer in reply to a question by Mr. Kotelawala first gave a brief review of the Scheme's work to date in 1935.

ESTATE

The Estate Progress Reports for June, July and August, 1935 were approved by the Board. The Chief Technical Officer said that as requested by Mr. Obeyesekere at the previous meeting, crop records and estate expenditure were now shown in the reports for the three past years for purposes of comparison.

COCONUT RESEARCH MUSEUM

A letter on the suggested establishment of a Museum at Bandirippuwa Estate, from the Hony. Secretary, Low-Country Products Association to the Chairman, had been circulated to the Board. In connection with this, the Chief Technical Officer said that, of course, there was not sufficient accommodation at Bandirippuwa to allow of a separate room being set aside as a Museum, but that arrangements could be made for a certain amount of exhibition work in the corridors. The geneticist was already arranging a wall exhibit of coconut varieties in his laboratory and it was proposed to move the large museum case to the centre of the building. The Acting Director of Agriculture had kindly agreed to provide exhibits on the Mycological and Entomological side. As far as exhibits of economic interest were concerned, the Chief Technical Officer asked whether the L.C.P.A. would through their members be able to supply some samples. Mr. L. W. A. de Soysa assured the Board that they would be prepared to help in any way. The Board decided to reply to the L.C.P.A.'s letter that whilst accommodation did not permit of a separate museum room being set aside at the Bandirippuwa Station, they agreed with the principle of arranging as far as possible for the exhibition of samples of general interest to visitors, and that they instructed the Chief Technical Officer to do all that was possible in this direction. The Board would be willing if necessary to sanction a small extra vote later for the purchase of extra wall cases, sample cases, bottles etc. as required.

The meeting adjourned at 1.20 p.m. A vote of thanks moved by the Chairman to Mr. Collins for allowing the use of his room was unanimously carried.

DEPARTMENTAL NOTES

COTTON CULTIVATION IN THE CENTRAL DIVISION

H. A. PIERIS, B.A., (CANTAB.) A.I.C.T.A. (TRINIDAD),
DIVISIONAL AGRICULTURAL OFFICER, CENTRAL

IT is encouraging to note that cultivation of cotton has made good progress in the Central Division during the last three years. The first "Cotton Purchase" organised in Dambulla (Matale North) in 1931 amounted to Rs. 283. In the following year, there was an increase of 6,064 lb. of seed cotton over and above the previous year's quantity brought for sale and the purchase realised a sum of Rs. 913·13 for the growers. The procedure adopted at the "Purchase" was to collect and grade cotton at purchasing centres and forward it to the Spinning and Weaving Mills, Wellawatte. The value of cotton was remitted by the mills for settlement among the growers. The full value was paid to the cultivators after deducting handling and transport charges. This system caused a slight delay of payment, after the cotton was despatched until final settlement of accounts, and as such the arrangement was not popular with the cotton growers. Last year, owing to the temporary closure of the mills, the Department of Agriculture made a cash advance for the purchase of cotton. Rs. 7·50 was paid for a cwt. of 1st. grade cotton, which was stored at the Experiment Station and later despatched to the mills when it re-opened business. The cotton was purchased by the mills at Rs. 11 per cwt. The balance was remitted to the cultivator after deducting handling and transport charges. The cash advance given to cultivators was a considerable help. The "Purchase" that year showed an increase of 6489½ lb. of seed cotton and the value was Rs. 1,401·89. Consequent upon the facilities provided for cultivators in organising convenient purchasing centres where cotton could be brought, graded and weighed, and also as a result of the monetary assistance given them most of the cultivators attending last year's purchase expressed a desire to bring a bigger area under cultivation if the same facilities were provided for them. This year's "Cotton Purchase" figures have demonstrated that facilities provided for the easy disposal of the crop at an economic price have stimulated growers to take a greater interest in this important money crop. The severe and protracted drought which occurred soon after the sowing of seed until the harvest contributed largely to a considerable loss of crop by the premature shedding of tender flowers and bolls. Consequently second picking in most places was not possible. Ravages of malaria, on the other hand, also played an important part, as owing to the inability of cultivators to tend their plots due to illness, systematic cultural operations were not possible. Despite all these setbacks, the crop harvested this year has shown an increase of 22,686 lb. of seed cotton over last year's purchase, and the sum realised for the growers was Rs. 4,136·37. These figures are exclusive of about 7,500 lb. of cotton produced in Gallewela and sold by cultivators direct. Therefore the nett output of cotton produced in the Dambulla district can be estimated at 46,326 lb. which shows an approximate increase of 30,186 lb. over last

year's figures. This year, cotton was purchased at Rs. 12 per cwt. The figures are encouraging and indicate that in a normal year, the cultivation in this district should appreciably increase. To create an interest in this commodity, it has been necessary to conduct much propaganda. Vernacular leaflets on cultivation of cotton were distributed, propaganda lectures arranged for, competitions organised and cotton seed distributed free of charge. The Rotation Station at Pelwehera served as a useful demonstration station, and as the principal purchasing centre. Owing to the lack of suitable land, cultivators are unable to grow cotton in a system of rotation of crops. Most cultivators are chena cultivators or possessors of small-holdings. The average holding is expected to produce a crop of cereals, vegetables, cotton, etc., as the cultivator feels that he should be self-sufficient in most of his essential requirements. With all these mixed crops there is no land for the adoption of a rotation scheme. Settlement schemes in close proximity to the Rotation Station will provide the necessary land for the adoption of crop rotation with cotton as the major money crop. Cotton grown at Nalanda and Matale South was also purchased at Nalanda Experiment Station and despatched to the mills. There has been an unprecedented demand for seed this year. Everything being normal, next year's "Cotton Purchase" should be very successful. For the first time a "Cotton Purchase" was organised this year in Walapane. A quantity of 3454 lb. of seed cotton was purchased realising for the growers a sum of Rs. 370·92. It is hoped that the "Purchase" would prove as an incentive to bring a bigger area under cotton this season, so that annual "Cotton Purchase" will be a regular event in the district. This year a cotton production campaign has already been organised with a view to bringing a larger area under cultivation.

The following are the chief factors that militate against the cultivation of cotton in the Dambulla district:

1. Lack of suitable and insufficient peasant proprietary schemes.
2. Transport difficulties.
3. Prevalence of Chena system.
4. Malaria.
5. Damage caused by wild animals and stray cattle.
6. General poverty of cultivators.

Enumerated below is a table showing "Cotton Purchase" for the last five years in the Dambulla district.

Year	No. of lb. purchased	Increase over previous year	Value of cotton purchased Rs. cts.
1930-31	2,756	—	283·00
1931-32	8,820	6,064	913·12
1932-33	9,650½	830½	981·17
1933-34	16,140	6,489½	1,401·89
1934-35	38,826	22,686	4,136·37

EXPERIMENT GARDEN, NUWARA ELIYA*

Fruit Trials.—During the third quarter 1935 the Experiment Fruit Garden of approximately 5 acres was terraced, drained and planted out with a supply of imported Australian grafts under the supervision of the Agricultural Instructor. The plants have been well spaced and suitably planted. The following are the varieties planted out: Apples, cherries, figs, peaches, pears, English plums, Japanese plums, quinces, oranges, mandarins, grape-fruit, lemons and limes.

Nurseries.—Several nurseries of local pear and plum stocks have been opened out with a view to building and introduction of budded plants in settlements in Nuwara Eliya Gravets.

Cauliflower & Cabbage Trials.—About ¼ acre was brought under cauliflower and cabbage trials with the following varieties:

Cauliflower:—Autumn Mammoth, Incomparable and Champion of England.

Cabbage:—Surehead and Allhead.

Autumn Mammoth proved to be the most successful variety and yielded a very good crop, some weighing 4-5 lb each (without leaves) and measuring 8-10 inches across. The total number of pounds of cauliflower harvested in August was 1354 lb and cabbage 322 lb. The revenue realised was Rs. 200.50.

The seed cabbage was however not up to standard. Further trials will be conducted in a plot of land specially reserved for trials with vegetables. The pest cut worm or black grub did considerable damage during the early stages of growth and vacancies had to be continually supplied.

Fodder Grass Trials.—Two acres were opened out with the following varieties of grasses. This area is to be maintained as a supply nursery for the purpose of encouraging suitable varieties of fodder grass in settlements and holdings.

Guinea Grass B.—5,000 roots.
Napier Grass.—5,000 roots.
Guatemala Grass.—3,000 roots.
Paspalum Lerangai.—3,000 roots.

Trials in Village Gardens.—A pound of cauliflower seed of the varieties, viz., Autumn Mammoth and Early Giant has been sent out for laying down demonstration plots in vegetable gardens in Kandapola and Blackpool. A suitable manure mixture will also be supplied with a view to making the trials a success. The new settlements in Katukelle will be brought under demonstration plots of potatoes, oniöns, celery and cauliflower no sooner than the colonists settle down and fence their lands. The land is suitable as it contains more or less virgin soil.

Competitions.—With a view to encouraging fruit cultivation, free issues of plants have been periodically given out in small-holdings. During the quarter under review a supply of 725 fruit plants were distributed in Kandapola and Blackpool settlements. A Fruit Garden Competition was also organised and final judging done by the Divisional Agricultural Officer in collaboration with the Agricultural Instructor, Nuwara Eliya. Cash prizes and Departmental Certificates were issued to the successful competitors.

---

* Extract from the Report of the Divisional Agricultural Officer, Central, for the Third Quarter, 1935.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31 OCTOBER, 1935.

Province, &c.	Disease	No of Cases up to Date since Jan. 1st 1935	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	43	...	43	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	15	...	...	...	...	15
	Piroplasmosis	...	...	...	...	...	...
Colombo Municipality	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	10	...	9	1	...	...
	Anthrax	2	...	...	2	...	...
	Rabies (Dogs)	29	9	...	...	...	29
	Haemorrhagic Septicaemia	...	...	...	...	...	...
	Black Quarter	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	...	...	...	...
Cattle Quarantine Station	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax (Sheep & Goats)	77	1	...	77	...	...
Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1	...	...	...	...	1
	Anthrax	5	2	1	4	...	...
	Black Quarter	18	...	...	18	...	...
	Bovine Tuberculosis	8	...	...	...	...	8
	Rabies (Dogs)	2	...	...	...	...	2
Southern	Rinderpest Foot-and mouth disease Anthrax Rabies (Dogs)	FREE					
Northern	Rinderpest Foot-and-mouth disease Anthrax Black Quarter Rabies (Dogs)	FREE					
Eastern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	40	...	40	...	...	...
	Anthrax	...	...	...	...	...	...
North-Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	193	70	148	5	40	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	21	2	...	4	...	17
	Piroplasmosis	...	...	...	...	...	...
North-Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	885	35	710	...	175	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	85	...	84	1	...	...
	Anthrax	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	...	...	...	...
Sabaragamuwa	Rinderpest	...	...	...	...	...	...
	Foot and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
	Piroplasmosis	2	...	1	1	...	.
	Haemorrhagic Septicaemia	22	10	3	19	...	...
	Rabies (Dogs)	5	...	...	...	...	5

Government Veterinary Department,
Peradeniya, 16th November, 1935.

M. WIJAYANAYAKA,
for Government Veterinary Surgeon.

METEOROLOGICAL REPORT OCTOBER, 1935.

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Inches		Inches.
Colombo	84·4	− 0·1	74·6	− 0·3	78	90	7·7	23·65	24	+ 10·40
Puttalam	86·0	+ 0·4	74·6	− 0·9	76	90	5·8	9·55	14	+ 1·47
Mannar	87·4	+ 0·2	77·1	− 0·1	74	86	6·3	4·83	11	− 2·16
Jaffna	86·8	+ 1·9	77·8	+ 0·7	70	80	6·4	9·55	12	− 0·03
Trincomalee	87·2	− 0·4	75·9	+ 0·6	72	86	6·6	3·91	11	− 5·23
Batticaloa	86·7	0	75·7	+ 0·8	73	88	6·4	4·50	13	− 2·57
Hambantota	86·5	+ 0·9	75·1	+ 0·2	76	91	6·0	5·02	16	+ 0·20
Galle	82·7	− 0·2	75·4	+ 0·2	79	88	6·7	13·08	23	+ 1·45
Ratnapura	86·9	+ 0·2	72·7	+ 0·1	78	100	7·1	18·62	26	+ 0·78
A'pura	89·8	+ 1·7	73·1	− 0·3	69	95	7·6	7·98	18	− 1·79
Kurunegala	87·7	+ 0·8	72·7	− 0·6	72	93	6·9	11·72	22	− 4·12
Kandy	84·6	+ 1·3	68·8	+ 0·2	72	92	6·2	16·90	20	+ 6·03
Badulla	82·8	0	65·6	+ 0·2	68	95	5·8	5·65	15	− 4·07
Diyatalawa	76·2	− 0·1	60·8	+ 0·3	67	89	6·8	9·60	19	+ 0·09
Hakgala	70·1	+ 0·7	55·4	− 0·7	84	88	6·7	7·76	21	− 5·04
N'Eliya	67·2	− 0·1	51·8	− 0·7	79	94	7·8	10·14	23	− 0·50

The deviations of October rainfall from normal were very irregularly distributed throughout the Island. In the north, west and south, the rainfall was generally in excess, and in the east in deficit, while up-country excess and deficit approximately balanced. Excess was most marked along the south-west coast, but a few stations in the Jaffna Peninsula, in the neighbourhood of Kandy, and in the south, also reported moderate excess. The greatest deficits below were found chiefly in Uva.

There were 39 reports of daily falls of 5 inches or over, the highest being 10·27 inches, at Culloden, on the 28th. A large majority of these heavy falls occurred either on the 17th, on the south-western slopes of the hills, or on the 28th, in the south-western coastal districts, but there were several also on the 13th, in the south-western foothills.

For the first half of the month weather conditions were of the usual intermonsoon type, with flattish gradients, generally light winds, and local afternoon or evening thunderstorms. About the 17th a depression formed to the north-east of Ceylon, and crossed the Indian coast near Madras on the 18th. It passed out into the Arabian Sea on the 20th. As a result of the formation of this depression, weather conditions were unsettled near Ceylon, with rough seas and squally weather, between the 17th and the 19th, and the winds continued mainly westerly till the 25th. The rain decreased on the 21st, and there was generally little rain until the 28th. During the last few days of the month weather conditions were again slightly unsettled, with extensive rain, and suggested the possibility of the formation of another depression in the Bay of Bengal near Ceylon.

Temperatures, humidities and cloud showed in general no marked deviations from normal. The humidity at Jaffna, however, was appreciably below normal, while the temperature there was a little above normal. Barometric pressures were below normal everywhere. Winds were generally fairly light, and on the whole showed no marked deviations from normal. Wind directions along the south and south-west coasts were generally westerly, elsewhere variable.

H. JAMESON,
Supdt., Observatory